V. A MIOCENE MICROFAUNA AND FLORA FROM THE ATRATO RIVER, COLOMBIA, SOUTH AMERICA.

By I. P. Tolmachoff

INTRODUCTION

In 1927, the writer received for examination a specimen of dark greenish fossiliferous limestone brought by L. G. Huntley[1] from a part of Colombia known geologically only in a very general way. As the specimen itself was found, after a preliminary examination, to be very interesting in different respects, the writer decided to examine it more in detail and publish the results of his research.

All species described in the present paper belong to the Carnegie Museum of Pittsburgh (collection No. 8016) and are deposited in the collections of the Sections of Invertebrate (C. M. I. F.) and Vertebrate (C. M. V. F.) Paleontology and also in the Paleobotanical collection of the Section of Botany. Reference to the catalog numbers is given after the description of each species, and also in the explanations of the plates.

With the exception of the photographs, all figures were drawn by E. R. Eller of the Carnegie Museum, to whom the writer feels deeply obliged for this friendly help.

L. G. Huntley delivered the following data as to the geology of the locality in which he had found the specimen:

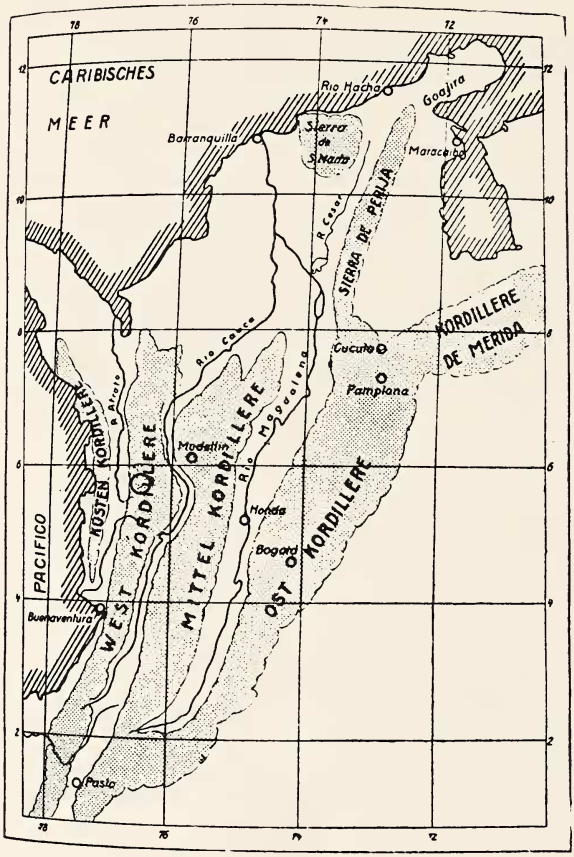
"The specimen of black fossiliferous lime occurs at the base of a thick section of shallow fresh-water shales and sands in the Atrato Valley, Colombia, on the west flank of the western Cordillera of the Andes Mountains,[2] about thirty kilometers due east from the town of Quibdo.[3] This is near the western boundary of the province of Antioquia in a region known as the Choco. From its position in the section, I should judge it must be of either Oligocene or Upper Eocene.

[1]Huntley and Huntley. Petroleum Geologists and Engineers. Pittsburgh, Pennsylvania.

[2]The most important geographical features of Western Colombia are represented schematically on the small map reproduced (in the scale about 150 miles to 1 inch) from Otto Stutzer's paper "Beiträge zur Geologie und Mineralogie von Kolumbien (Südamerika)" published in Neues Jahrbuch f. Min., Geol. u. Pal., B. Bd. LII, Abt. B, 1925. S. 163.

[3]It will correspond approximately to 76° 28′ W. and 5° 45′ N. The locality is marked on the map with a circle.

Issued August 10, 1934.



This is for the reason that as one travels eastward toward the mountains, a thick section of Middle and Lower Eocene coal beds is encountered below this black limestone. There is an angular unconformity a short distance stratigraphically below the black limestone from which this specimen was taken."

The previous knowledge of geology of this area is very inadequate. "Concerning the Atrato River Valley, neither of us knows anything" say Washburn and White.[4] According to Stutzer "Westkordillere ist geologisch fast unbekaunt."[5] About the Coastal Cordillera he

[4]Washburn, W. and White, K. D., Oil Possibilities of Colombia: Trans. A. I. M. M. E., LXVIII, 1923, p. 1031.

[5]Stutzer, O., Beiträge zur Geologie und Mineralogie von Kolumbien (Südamerika): Neues Jahrbuch, Beil. Band LII, Abt. B, 1925, S. 164.

says: "Dieselbe ist noch wenig erforscht." So far as is known to the writer, nothing has been published on the geology of the particular part of Colombia from which the specimen was brought except in general geological reviews of the geology of Colombia or of the northern part of South America, covering, of course, this area as well. It is unlikely that some unpublished geological report may be found in the files of different concerns interested in the oil geology of Northern Colombia. As has been positively stated to the writer by L. G. Huntley and his associates who are well informed on all the geological and mining work carried on in this part of South America, no geologist since L. G. Huntley has visited this locality.

About the same thing may be repeated in reference to the paleontology of this area. Papers on Tertiary fossils of Colombia published lately by F. M. Anderson[6] and N. E. Weisbord[7] refer chiefly to fossils from the coastal regions of Colombia and deal almost exclusively with the macrofauna. Anderson's papers have indeed many references to abundant and diverse Foraminifera, but only a few of the latter were described in detail. The microfauna of Colombia which has been examined by paleontologists of different oil enterprises still awaits description. As the writer has learned by chance such a description is now in preparation, but it still refers to localities very distant from the one under consideration.

It was a rather difficult job to extract the fossils from the hard rock, especially as the specimens were small and provided little material for experimenting. At first the writer tried strong heating of the specimens followed by quick cooling in water. A number of fossils were obtained in this way, but the rock and fossils were becoming reddish brown, and the fossils were often partly damaged. Most of the fossils were cleaned out by means of simply crushing the rock specimen with a heavy hammer, the specimen itself being wrapped in thick paper. The first crushing yielded rather coarse material. Fragments were examined under a microscope and a few fossils cleaned out with the usual instruments. After examination, the crushing was repeated.

[6]Anderson, F. M., I. The marine Miocene Deposits of North Colombia: Proc. Cal. Ac. Sc., IV Ser, XVI, 1927, pp. 87-95, pls. 2-3; II. Notes on Lower Tertiary Deposits of Colombia and their molluscan and foraminiferal Fauna: Ibidem, XVII, 1928, pp. 1-29, pl. 1; III. Marine Miocene and related Deposits of North Colombia: Ibidem, XVIII, 1929, pp. 73-213, pls. 8-23.

[7]Weisbord, N. E., Miocene Mollusca of Northern Colombia: Bull. Am. Pal., XIV, No. 54, pp. 1-74, pls. 1-9, 1929.

This time much of the finer material was washed out by passing the crushed rock through sieves of different meshes. The different portions obtained in this way were examined under a microscope, the fossils picked out and cleaned finally with brush and needle. Adhesive tape, on which the fossils were fixed for cleaning, was used very successfully in the way described by the writer in another place.[8]

This crushing method was good for microfossils, but certainly was detrimental for larger ones. Bryozoa, for example, were thus obtained only in the form of fragments which could not be well identified. Most of the gastropods were cleaned out of the matrix in the form of inner casts. One very interesting and abundantly represented form *Asterias* (?) *huntleyi* m. was recovered only in the form of isolated disconnected parts.

CORRELATION

As was mentioned above, L. G. Huntley concluded that the fossiliferous limestone was either Oligocene or Upper Eocene, chiefly because of its overlying coal beds which he believed to be of the Middle and Lower Eocene. However, he mentioned also an angular unconformity below the black limestone, which makes the correlation, inasmuch as it depends on connection with coal beds, not so safe. The black limestone can, therefore, have a much higher stratigraphic position than was suggested by L. G. Huntley. Even though coal-bearing strata may be Eocene, this cannot be definitely established at the present time. In White's opinion Colombian coal may be Eocenic or even Cretaceous.[9] According to Grosse, geologists Regel, Tulio Ospina, and Posada considered the coal formation of Antioquia Cretaceous, while Scheibe attributed to it a Tertiary age, chiefly on account of an unconformity at the base of the formation.[10]

A few animal fossils collected by Grosse in the coal formation were identified by Steinmann who attributed to them the late Middle or even Young Tertiary Age.[11] More numerous plant fossils were examined by Kransel who considered them to be Lower Tertiary.[12] Grosse himself was apparently more in favor of Kransel's correlation

[8]Tolmachoff, I. P., A Method of Cleaning Microscopical Fossils: Science, LXXIII, No. 1879, January 2, 1931, p. 15.

[9]Washburn, W. and White, K. D., Op. cit., p. 1023.

[10]Grosse, E., Geologische Untersuchung des Kohlenführenden Tertiärs Antioquias, S. 105, Berlin, 1926.

[11]Grosse, E., Op. cit., S. 104.

[12]Ibidem.

than Steinmann's although he did not deny the possibility of a higher position of coal-bearing strata "höchstens mitteltertiäres Alter."[13] Grosse came to his conclusion, however, not so much on the basis of paleontological evidence, as of general geological relations between coal-bearing strata and other formations of the Northwestern part of South America. The Colombian Coal Formation can not be Cretaceous, since it is clearly younger than the Lower Tertiary granite and diorite of the Andes.[14] Correlation with the coal formation of Northern Peru is also impossible because the latter was deposited during a period of great eruptive activity in the Tertiary. This activity could not have been earlier than the Middle Tertiary, as is shown by the rich fossil flora found in volcanic tuffs in Bolivia. In Antioquia effusives are lacking within the coal formation, but cover it. Thus the Colombian coal is older than that of Peru and is not represented in the latter country. In some localities the Colombian coal formation is also covered discordantly by young Tertiary conglomerates[15] which fact certainly limits the possibility of its eventual correlation with high Tertiary horizons.

Since the layer of limestone under consideration lies above the coal-bearing formation, all this difference of opinion as to the age of the latter affects directly the correlation of the limestone, which, from its position in the section, may be Oligocene just as well as Miocene.

Paleontological evidence is rather decidedly in favor of the Miocene as the age of the limestone. Foraminifera, the most important part of the fauna, are represented exclusively by so called smaller Foraminifera. The larger Foraminifera or, in general, forms typical of the Lower Tertiary, are absent completely. Although several species in the fauna are known also from the Lower Tertiary and even from the Cretaceous, these are forms of a wide vertical distribution appearing through the whole Tertiary and common in the recent seas. The most comparable foraminiferal faunas are, however, the Miocene ones of the New and Old Worlds, as will be shown in the following description of species in which the correlation is considered in detail when possible. Miocene faunas described from Northern Colombia, being chiefly macrofaunas, cannot be compared directly with the microfauna described in this paper, but they show a wide general distribution of the Miocene in Northern Colombia. Weisbord mentioned a great thickness of Miocene beds in the Atrata River Valley.[16] Quite

[13]Ibidem, p. 105.
[14]Ibidem, p. 335.
[15]Ibidem.
[16]Op. cit., p. 3.

possibly the Miocene of Northern Colombia penetrates into that valley and perhaps even is represented by the strata of which the fauna is described in this paper.

The specimen delivered to the writer was very rich in fossils. The described fauna, however, can hardly be considered as representing the typical fauna of this layer. Such a fauna could be brought together only with much more abundant material than that in the hands of the writer. Any attempt at more exact correlation or comparison of this fauna with some known Miocene fauna could not be therefore successful. Tentatively, the writer is ready to consider the fauna as rather closely related to the fauna of the Gatun Formation of the Panama Canal Zone.[17] *Lithothamnium colombianum* m., found among the animal fossils, gives strong support to such a correlation. As is mentioned in the description of this species, it is very similar and perhaps even identical with *Lithothamnium isthmi* Howe from the Emperador Limestone of the Panama Canal Zone, which represents the Uppermost Oligocene. In the rock specimen examined, this alga was found in the form of small pebbles rolled out by water, that is, in a secondary location of a later age than that of the Emperador Limestone. These conditions bring the correlation again toward the Miocene and the Gatun Formation.

DESCRIPTION OF THE ROCK SPECIMEN

The largest part of the examined rock was easily dissolved in cold hydrochloric acid with strong effervescence. After the latter has stopped, slight heating provokes it for a short time again. The acid extracts some Al, but very little Fe, although heating the rock fragments makes them brown. After the treatment with acid there always remains some amount of undissolved material. In the field the rock may be therefore called limestone, as it was indeed identified, but limestone which is slightly dolomized and in general impure.

The rock was analyzed at the Pittsburgh Station of the United States Bureau of Mines with the results given below.[18] Column I

[17]Vaughan, Th. W., The biologic Character and geologic Correlation of the Sedimentary Formations of Panama in their Relation to the geologic History of Central America and West Indies: U. S. Nat. Mus. Bull. 103, p. 586. ff.

[18]The writer wishes to express his sincere gratitude to Dr. G. St. J. Perrott, Superintendent of the Pittsburgh Station of the Bureau of Mines, with whose permission the analysis was done at this Institution, and also to Dr. W. A. Selvig who analyzed the specimen.

gives the original figures of the analysis. To obtain the figures in column II, a recalculation was made by the writer in such a way that all the moisture (0.9%), water (2.4%) and CO_2 (28.9%) were taken out, as well as the amount of CaO corresponding to that of CO_2. A part of the latter was combined in the rock with MgO, but this combination was neglected and the content of MgO left intact. The remainder (39.08%) was taken for 100 per cent and all components were recalculated accordingly.

	I	II
SiO_2	17.8	45.5
Al_2O_3	3.9	10.0
Fe_2O_3	3.0	7.7
FeO	1.4	3.6
CaO	38.2	23.8
MgO	1.8	4.6
Na_2O	0.3	0.8
K_2O	0.6	1.5
S	0.3	0.8
SO_3	0.1	0.3
CO_2	28.9	...
P_2O_5	0.58	1.5
Water	2.4	...
Moisture at 105°	0.9	...
	100.18	100.1

Microscopic examination of slides and sifted material discloses the psammitic nature of the rock, which is composed of pebbles, fragments of minerals and rocks, and numerous plant and animal microfossils bound together with calcareous cement. Rather numerous grains of quartz and a few of plagioclase are usually subangular as are lamellae of biotite. There is an abundance of small opaque pebbles, often well rounded, ball or ovoid shaped, and highly polished and brown, reddish, greenish, or black in color. Under a microscope it is possible in some of them to distinguish a few small grains of quartz. These pebbles remind one of felsite and felsitic ground-mass, or, speaking generally, devitrified ground-masses. Black or almost black pebbles with a greenish tint are, probably, composed of glauconite which also makes local irregular aggregates of a dirty green color and very often fills the chambers of foraminifers, shells of gastropods, etc., producing in this way, as always, very fine inner casts. Rough irregular grains remind one of lapilli. They often have a conchoidal glossy surface and may be of an obsidian nature. Besides pebbles and fragments of volcanic rocks, there are also a few fragments with small grains of

pyrite, which originated probably from metamorphic rocks. There are abundant pebbles of calcareous algae as well as others, also calcareous, but structureless, although probably of organic origin as well.

Foraminifera in the fauna are usually well preserved, but minute gastropods are found only in the form of black inner casts. Often the fossils have been changed chemically. In this case shells are only partly affected by hydrochloric acid, which discolors the mineral substance filling or composing the shells, but does not destroy the fossils themselves.

The greatest part of the carbonate of lime found in this rock belongs to the fossils. Calcareous cement originated probably also from shells and calcareous algae. A rock of such character could be hardly called limestone. It is rather a calcareous sandstone of somewhat tuffoid character, because to a great extent it originated from volcanic ashes deposited on the bottom of the Miocenic Sea. It was probably a rather warm sea, as is shown by the great abundance of *Amphistegginae*, perhaps the most common foraminifer in the fauna. *Lithothamnia* are also mostly found in warm and shallow seas.[19] Since this alga was found in the form of pebbles, that is, in a secondary locality, the conclusions as to ecological conditions based on the presence of this alga refer to its primary locality. The locality was, apparently, not far from the shore of the sea. From this shore small polished pebbles and all psammitic materials were delivered to the deeper sea.

The microscopic character of the volcanic pebbles permits one to consider them as having originated from the ground-mass of dacites, a Tertiary volcanic rock very common in the Cordillera of Colombia. The rather abundant biotite in the examined specimen shows the possibility of relation with the biotite-amphibole dacite which, according to Küch,[20] is in Colombia the most common member of the dacite group. It may have been the original rock for ground-mass pebbles and fragments of plagioclase, biotite, etc.

The fact that the examined rock was partly of volcanic origin also gives some indication of its geological age, since the most important volcanic activity in the Cordillera occurred during the Upper Tertiary time and began in the Miocene.[21]

[19]Schenck, H. G., The biostratigraphic Aspect of the Micropaleontology: Jour. of Paleontology, II, 1928, p. 162.

[20]Küch, Richard, Die vulkanische Gesteine in W. Reiss und A. Stubel's Reisen in Süd-America, S. 50, Berlin, 1892.

[21]Steinmann, G., Geologie von Peru, SS. 208, 210. Heidelberg, 1929.

DESCRIPTION OF THE FAUNA

PISCES—TELEOSTEI

Family SCOMBRIDAE (?)

SCOMBRAMPHODON (?) Woodward

Scombramphodon (?) sp.

Plate XXXIX, figs. 1-6

Very small smooth teeth of an irregular conical form with a blunt rounded end. The root is broken off. Enamel white and transparent. The largest tooth (fig. 4) is 0.35 mm. long, two others are only a little over 0.3 mm. long.

It is hardly possible to find out, with any certitude, generic and even family relations of these interesting fossils which are unfortunately too incomplete for exact study. The writer prefers, however, to describe these remains under a quite tentative name, but not to leave them without any mention.

C. M. V. F. No. 5423-5425.

Scombramphodon (?) sp.

Plate XXXIX, figs. 7-10

Small smooth teeth with broken off roots are distinguishable from those described above by their size, which is about twice as great, elliptical cross section, and a triangular form a little different in the two present specimens. Enamel is of a greenish tint. The largest tooth (fig. 8) is 0.7 mm. long, the other one (fig. 10)—0.6 mm.

As in the previous case, identification is quite tentative here and these two teeth may even belong to an entirely different group of fishes.

C. M. V. F. No. 5426-5427.

CRUSTACEA—OSTRACODA

Family CYTHERELLIDAE

CYTHERELLA Jones

Cytherella atrata sp. n.

Plate XXXIX, figs. 11-14

The shell has an almost regular elliptical outline with the ventral border a little straighter than the hinge border. In the inner casts the ventral side is slightly concave. The horizontal section is more or

less ovoidal with the greatest thickness a little in front of the center or about at the center of the shell. The larger right valve overlaps the left one all the way around with strongest overlapping on the hinge margin which is somewhat thickened. Contact line of both valves is a little undulating on the ventral border. Inner casts bear impressions of a strong central muscle. The surface of the shell is smooth with a few small irregularly distributed holes.

DIMENSIONS IN MM.

	Length	Height	Thickness
Complete specimen	0.7	0.5	0.3
An inner cast	0.7	0.5	0.3

This species is fairly closely related to *Cytherella reussii* J. & Sh.[22] from Bracklesham Beds of England (Eocene), but has its greatest thickness close to the middle of the shell and lacks therefore, in the edge-view, the lanceolate outline of the English species.

C. M. I. F. No. 6945-6946, 6989.

MOLLUSCA—GASTROPODA

Family TURBINIDAE

TURBO Linnaeus

Turbo sp.

Plate XXXIX, figs. 17-18

The shell has the form of a flat spiral of two rounded whorls, besides the innermost one which could be destroyed. Umbilicus shallow and wide. No sculpture is seen on the inner cast, except, perhaps some faint marks of growth.

In its general appearance this species corresponds to many *Turbinidae* with round whorls. The largest diameter 0.5 mm.

C. M. I. F. No. 6948.

Turbo sp.

Plate XXXIX, figs. 19-20

In general, this species corresponds to that described above, but has the whorls comparatively stouter, and umbilicus narrower and deeper than in the former. Besides that, it is a left-handed form. The largest diameter equals 0.4 mm.

C. M. I. F. No. 6949-6950.

[22] Jones, T. Rupert and Sherborn, C. Davies, A Supplementary Monograph of the Tertiary Entomostraca of England: Monogr. Pal. Soc. London, 1889, p. 47, pl. II, figs. 4 and 8.

Turbo sp.

Plate XXXIX, figs. 21-24

A low turbinate, almost discoidal shell, probably of two round rather loose whorls increasing in size very gradually. Umbilicus rather narrow. The diameter of the largest specimen is over 0.4 mm. In one case can be seen the traces of transverse sculpture.

C. M. I. F. No. 6951-6953.

Turbo sp.

Plate XXXIX, fig. 25

The only specimen of a small *Turbo* (?). In general it is very similar to that described above, but distinguished from it by the left-handed coil and more rapidly enlarging whorls. The largest diameter is 0.3 mm.

C. M. I. F. No. 6954.

Family TROCHIDAE

TROCHUS Linnaeus

Trochus sp.

Plate XXXIX, figs. 15-16

A fragment of a small gastropod of a trochoid shape, composed of three incomplete whorls flattened from the periphery and making a low conical shell, with an apical angle of over 80°. The base was, apparently, flattened. The last whorl has remnants of sculpture consisting of transverse elliptical furrows, rather distant from each other. Height 0.2 mm., width 0.3 mm.

C. M. I. F. No. 6947.

Trochus sp.

Plate XXXIX, fig. 26

A conical shell composed of four gradually enlarging whorls slightly flattened from the periphery. Apical angle of about 50°. Umbilicus apparently absent. Aperture, probably, incomplete. No sculpture is noticeable on the inner casts. The most perfect specimen is 0.3 mm. in height of which 0.2 mm. corresponds to the spire. The width is 0.25 mm. Two other fragments belong to specimens more than twice as large.

In general shape and by its rounder whorls this form reminds one of *Hydrobia* sp. described below, but is distinguishable from it by the somewhat flattened whorls.

C. M. I. F. No. 6955-6956.

Family NATICIDAE

NATICA Lamarck

Natica sp.

Plate XXXIX, fig. 27

Shell somewhat compressed in a vertical direction, with the height about ⅔ of the width, composed of about four rounded whorls, the last of which is almost four times higher than the spire. The suture is very shallow, and the whorls are poorly separated from each other, as well as the last whorl from the spire. This gives the species a regular rounded shape. Aperture more or less ovoidal. Umbilicus, apparently, covered. No sculpture could be observed on the only inner cast present. Shell probably very thin. The greatest diameter 0.46 mm., the height over 0.3 mm.

C. M. I. F. No. 6957.

Natica sp.

Plate XXXIX, fig. 28

Shell of about the same height and width, 0.35 and 0.38 mm. respectively, composed of four whorls, the last one of which is about twice as high as the spire. Suture well expressed. Aperture apparently more or less ovoidal. Umbilicus very narrow or closed. No sculpture could be discovered.

To a certain extent this species corresponds in general appearance to some species of the genus *Amauropsis* Moerch. From three present specimens the smallest one is comparatively a little higher than the other two.

C. M. I. F. No. 6958-6959.

Natica sp.

Plate XXXIX, fig. 29

A left-handed shell composed of three ovoidal, laterally compressed whorls, the last of which occupies ¾ of the whole height of the shell. Umbilicus narrow. Suture rather deep. Surface apparently smooth. The largest diameter about 0.5 mm., the whole height about 0.4 mm., that of the last whorl 0.3 mm.

C. M. I. F. No. 6960.

Natica sp.

Plate XXXIX, fig. 31

Shell composed of three ovoidal whorls, not compressed laterally as in the previous species, and the shell thus having a somewhat

different appearance. Suture rather deep. The surface presumably smooth. The largest diameter over 0.4 mm.

C. M. I. F. No. 6963-6964.

Family HYDROBIIDAE

HYDROBIA Hartmann

Hydrobia sp.

Plate XXXIX, fig. 30

Shell conical, composed of four or five round, gradually enlarging whorls. Apical angle about 40°. Umbilicus absent or very narrow. Aperture rounded, oval. The last whorl about 1.5 of the spire. No sculpture could be seen on the present inner casts. Probably, the shell was thin and smooth. The whole height of the best preserved specimen was about 0.7 mm., the spire about 0.25 mm., the width about 0.5 mm.

C. M. I. F. No. 6961-6962.

BRYOZOA—CYCLOSTOMATA

Family HETEROPORIDAE

HETEROPORA Blainville

Heteropora elliptica sp. n.

Plate XXXIX, fig. 32

The zoarium subcylindrical, apparently solid, more than 1.6 mm. thick. Apertures elliptical all more or less alike and about of the same size with the larger diameter of 0.2 mm., and the smaller one about one-half of the former. Walls between the apertures about 0.08 mm. thick, with small pores. Tubes apparently cylindrical, bent on the ends towards the periphery.

Typical for this species is the elliptical shape of apertures and their comparatively large size, both characters distinguishing it from *Heteropora tecta* Ulrich[23] with which the species under consideration has, in general, a rather close affinity.

C. M. I. F. No. 6965-6966.

[23]Maryland Geological Survey, Eocene, Systematic Paleontology, Bryozoa by E. O. Ulrich, p. 210, pl. LIX, figs. 15, 16. 1901; comp. also Canu, F. and Bassler, R. S., North American Early Tertiary Bryozoa: U. S. Nat. Mus. Bull. 106, p. 682, pl. 104, figs. 14-20, 1920.

Heteropora sp.

Plate XXXIX, figs. 33-34

This form is represented only by fragments which do not give any idea about the general shape of the zoarium, but show some details of the inner structure. Apparently this form is closely related to *Heteropora elliptica* m., being perhaps only a variety of the latter. The only character distinguishing the two forms is the size of the tubes, the diameter of which in *Heteropora* sp. is about one-half of that observed in *Heteropora elliptica* m.

C. M. I. F. No. 6967-6968.

Heteropora sp.

Plate XXXIX, fig. 36

Zoarium small, massive, subramose with short thick branches rounded on the ends. Orbicular apertures, about 0.05 mm. in diameter or a little larger, distributed rather regularly over the whole surface of branches. Walls between apertures comparatively thick, about 0.05 mm.

This species is distinguished from both species of *Heteropora*, described above, by the general shape of the zoarium, by the circular apertures, and by the small diameters of the latter.

C. M. I. F. No. 6970-6971.

Heteropora (?) **amalgamata** sp. n.

Plate XXXIX, fig. 35

Zoarium small, apparently of low bushy shape composed of stout branches. Apertures orbicular, very small, with diameters not larger than 0.02-0.03 mm., distributed rather regularly over the surface of the zoarium, being more than 0.3 mm. distant from each other.

The surface of the walls between apertures is quite flat, which gives it a somewhat different appearance from other *Heteroporae* described above. *Heteropora amalgamata* m. is distinguishable also by its very small apertures which are twice as small as in the species of fig. 36, although for that species also are typical small apertures. The walls between the apertures are, however, comparatively thicker in this species than in the other ones.

C. M. I. F. No. 6969.

ECHINODERMATA

ASTEROZOA—ASTEROIDEA

Family ASTERIIDAE

ASTERIAS (?) Linnaeus

Asterias (?) huntleyi sp. n.

Plate XXXIX, figs. 37-49; pl. XLII, figs. 32-34

In the material under investigation there were found abundant, minute fossils the identification of which gave much trouble and which should be accepted *cum grano salis*. They are of a very variable shape, often irregular. However, they are grouped together because of their sculpture, which consists of small tubercles distributed, in most cases, rather irregularly and sparsely, but sometimes covering completely the given surface. Rarely the tubercles are distributed in rows and then cover the microscopical body all around. Usually, even when abundant, they cover only one side of the fossil. On the basis of their shape these fossils may be distributed in the following groups:

A. Figs. 37-39. Seed-like bodies of flattened ovoid form, 0.5–0.6 mm. long, or even a little longer. They taper toward both ends, but on the one have a neck-like joint a little hooked to one side which usually is tubercular and more flattened than is the other one. The latter sometimes bear tubercles, also, but usually in lesser number and distributed rather irregularly. Oftener this side is smooth or irregularly ribbed. The only interpretation which, in the writer's opinion, it is possible to offer for these fossils is to regard them as pedicellariae of sea stars, or, better to say, isolated jaws of pedicellariae. Since they have been found in such a fragmentary condition, it is very difficult to give their exact and complete description. Apparently they belonged to a so-called straight not crossed forcipiform (pincer-shaped) type and probably to the pedunculate one. They cannot be pedicellariae of *Echinoidea*, which are much more regular than those of *Asteroidea*. Certainly it would be hardly possible to identify, even generically, the star to which they could belong. The very common and widely distributed genus *Asterias L.*, known also in fossil forms, into association with which these remains have been brought, has

abundant pedicellariae of this type. They are described as belonging to a new species on account of their sculpture which, being of a type common among sea-stars, does not appear in just such a form in any species known to the writer. The specific name is given in honor of L. H. Huntley, to whom the writer is obliged for this interesting specimen of limestone.

B. Figs. 40-43. Partially lenticular, rather thick bodies, covered on two surfaces with narrowly distributed tubercles. The lens is cut off on one side and bears here a shallow concavity divided by low ridges and tubercles. The shape of this concavity is such that it cannot be considered as other than the surface of a joint. Thus, all these bodies may be basal plates of pedicellariae. They are, however, comparatively large (1.0, 0.8, 0.9 mm.) and cannot be brought into direct connection with the pedicellariae described above. They may represent, however, basal pieces of crossed pedicellariae which are known in this genus, along with the straight ones.

C. Figs. 44-45. Plates bearing one rather large tubercle of varying structure. Some of them are low, located in the middle of the plate or anyhow some distance from its border and separated from the surface of the plate by a neck. Other tubercles are high, gradually confluent with the plate and located near its border. Tubercles of the first kind have a joint surface on the top and, probably, supported spines, pedicellariae not excluded. The second kind of tubercles may have been spines by themselves, although they also have a joint surface on the top. The surfaces of the plates themselves are usually smooth or bear a few isolated papillae, sometimes more abundant along borders.

D. Fig. 49. Fragments of spines roughly cylindrical or conical, rather irregular, bearing abundant or scarce tubercles distributed usually irregularly, or locally in rows. Along with the ornamented spines there are found a few smooth ones of different sizes, cylindrical or conical, slightly bent and then more or less bluntly ended or straight. They may be the dermal outgrows of star fishes.

E. Figs. 46-48. Plates of a rather irregular form with papillate sculpture. They are fragments and partly, probably, complete dermal plates of star fishes.

C. M. I. F. No. 6972-6988, 7074-7077.

HOLOTHUROIDEA

Family SYNAPTIDAE

CHIRIDOTA Eschscholtz

Chiridota (?) sp.

Plate XL, fig. 1

Only one specimen of a hook-like spicula, apparently not complete, corresponding very closely to the hook shaped spiculae of *Chiridota*,[24] although it is much larger and comparatively thicker than the latter. However, it is hardly possible to bring this small specimen into connection with any group of animals, except *Holothuroidea*. It is about 2.3 mm. long and 0.6 mm. thick in the thickest section.

C. M. I. F. No. 6990.

FORAMINIFERA

Family RHIZAMMINIDAE

BATHYSIPHON (?) M. Sars

Bathysiphon (?) sp.

Plate XL, figs. 2-3

Two small fragments of tubular form which may belong to the same specimen. General form subcylindrical, a little bent, and slightly tapering to one end. Walls are rather thick, 0.05 mm. on the section of 0.2 mm. diameter. Their supposed agglutinated structure could not be distinguished, which makes generic identification rather uncertain. The central channel is closed at the thick end, but apparently in a secondary way. The surface is smooth with inconspicuous and irregular annular contractions. The lengths of the two fragments are respectively about 0.8 and 0.6 mm., which brings the whole length to 1.4 mm. The diameter is over 0.3 mm. at the thicker end and over 0.2 mm. at the thinner one.

C. M. I. F. No. 6991-6992.

Family VERNEUILINIDAE

VERNEUILINA D'Orbigny

Verneuilina fusiformis sp. n.

Plate XL, figs. 4-5

Test free, bipyramidal, three-serial, the apical end rounded more bluntly than the basal one which is rather acute. The height and

[24]Bronn's Kl. und Ordn., Bd. II, Abth. 3, Buch 1, Taf. I, fig. 6. Review of fossil Holothuroidea is given by C. Croneis and J. McCormack, Journ. Pal., VI, pp. 111-148, pls. 15-21.

width are about equal, thus making outlines of the test rhombic, or the height is a little greater than the width. Transverse section triangular with rounded corners and somewhat inflated sides. Aperture, which could not be well observed, is apparently terminal and rounded. Surface smooth. Test is apparently calcareous through and through.

DIMENSIONS IN MM.

Height	Width
0.6	0.4
0.5	0.5

This species is distinguished from other species of this genus by its bipyramidal shape and by the cross-section which is more triangular than usual. At the same time it has rounded corners and could hardly be considered as belonging to the genus *Tritaxia* Reuss. Unfortunately the character of the aperture could not be well ascertained. Apparently it corresponds, perhaps, in structure more to the genus *Tritaxia* Reuss than to that of *Verneuilina* D'Orb. *sensu stricto*.

Verneuilina mexicana Nuttall[25] from the Lower Oligocene of Mexico reminds one, in its general shape, of the species under consideration.

C. M. I. F. No. 6993, 6995.

Verneuilina sp.

Plate XL, figs. 6-7

The only specimen of this form is distinguished from the *Verneuilina fusiformis* m. by its more cylindrical shape, almost round transverse section, relatively greater height and smaller general size. The height is about 0.43 mm., the width about 0.3 mm.

C. M. I. F. No. 6994.

Family MILIOLIDAE

QUINQUELOCULINA D'Orbigny

Quinqueloculina seminula Linnaeus

Plate XL, figs. 8-10

1767. *Serpula seminulum* Linnaeus, Systema naturae, Edition XII, p. 1264, No. 791.

1884. *Miliolina seminulum* Brady, Report on the Foraminifera dredged by H. M. S. Challenger during the years 1873-1876: Challenger's Report, Zoology, IX, p. 157, pl. V, figs. 6a-c, (Synonymy).

[25]Nuttall, W. L. F., Lower Oligocene Foraminifera from Mexico: Journ. Pal., VI, p. 6, pl. 2, fig. 1-2, 1932.

1917. *Quinqueloculina seminulum* Cushman, A Monograph of the Foraminifera of the North Pacific Ocean: U. S. Nat. Mus. Bull. 71, part 4, p. 44, fig. 29, pl. 11, figs. 2a-b.

1918. *Quinqueloculina seminulum* Cushman, The smaller fossil Foraminifera of the Panama Canal Zone: U. S. Nat. Mus. Bull. 103, p. 78, pl. 27, figs. 4a-b; pl. 28; pl. 29, figs. 1a-e.

1921. *Quinqueloculina seminulum* Cushman, Foraminifera of the Philippine and adjacent Seas: U. S. Nat. Mus. Bull. 100, vol. 4, p. 416, figs. 19-20, pl. 88, figs. 4a-c.

1922. *Miliolina seminulum* Protescu, Contribuţiuni la studiul faunei de Foraminifere terţiare diu România: Anuarul Institutului Geologic al României, IX, p. 296, Taf. III, fig. 3.

1929. *Quinqueloculina seminulum* Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 6, p. 24, pl. 2, figs. 1a-c, 2a-c.

1929. *Quinqueloculina seminulum* Cushman, On *Quinqueloculina seminula* (Linné): Contr. Cushman Lab., V, p. 59, pl. 9, figs. 16, 17, 18a-c.

1930. *Quinqueloculina seminulum* Cushman & Valentine, Shallow Water Foraminifera from the Channel Island of Southern California: Contr. Dept. Geol. Stanford Univ., I, No. 1, p. 10, pl. 1, figs. 8a-c.

1930. *Quinqueloculina seminulum* Cushman & Cole, Pleistocene Foraminifera from Maryland: Contr. Cushman Lab., VI, p. 95, pl. 13, figs. 1a-c.

1930. *Quinqueloculina seminulum* Cushman, The Foraminifera of the Choctawhatchee Formation of Florida: Florida St. Geol. Survey, Bull. No. 4, p. 19, pl. 2, figs. 1a-c.

1931. *Quinqueloculina seminulum* Kornfeld, Recent littoral Foraminifera from Texas and Louisiana: Contr. Dept. Geol. Stanford Univ., I, p. 83, pl. 14, figs. 4a-c.

1933. *Quinqueloculina seminulum* Cushman & Cahill, Miocene Foraminifera of the Coastal Plain of the Eastern United States: U. S. G. S. Prof. Paper 175-A, p. 9, pl. 2, figs. 2a-c.

Test longer than wide, ovoidal with greatest width near the middle. Chambers of almost uniform thickness with rounded periphery, well separated from each other by distinct sutures. Wall smooth and shiny. Aperture rather large with a simple thin, rather long tooth. Apertural end apparently not protruding, although its truncation cannot be observed well in Colombian forms because their last chamber is usually broken off. The average length is over 0.5 mm.

Under this specific name are included so many different forms of smooth *Quinqueloculinae* that, in Cushman's opinion, it would be unwise to attempt to give a detailed synonymy for this species.[26] Referring to Brady's description, Cushman points out that the text figures in the Challenger report, representing this species, show very different forms and adds "The synonyms are probably numerous, but hardly as many as indicated by Brady."[27] The correctness of Brady's

[26]U. S. Nat. Mus. Bull. 104, part 6, p. 25.

[27]Contr. Cushman Lab., V, p. 60.

identification is also questioned by Galloway and Wissler[28] in whose opinion *Miliolina seminulum* L. described by Brady is *Quinqueloculina akneriana* D'Orb. This view is shared by Thalmann[29] as well as Cushman and Stewart.[30] According to both last authors, *Quinqueloculina akneriana* D'Orb. is "somewhat shorter and more rounded" than the closely related *Quinqueloculina seminula* L. The latter species also was revised by Cushman who had an opportunity to visit the locality from which Linne's species had been obtained and to collect there abundant new material. According to Cushman "The name *Quinqueloculina seminula* L. should be applied to the smooth quinqueloculine form, with rounded or very slightly angled chambers, with a truncated apertural end, and the aperture with a simple tooth."[31] The new specimens figured by him correspond very closely to those given by Brady in their general shape and dimensions; in both cases the relation between the length and width is about 1.6, while for *Quinqueloculina akneriana* D'Orb. it equals 1.3. Since this difference is the most important character distinguishing the two species, it is hardly advisable to bring *Quinqueloculina seminula* L. described by Brady into association with *Quinqueloculina akneriana* D'Orb. or to include the latter species in the synonymy of the former. Colombian forms correspond very well to Cushman's definition of the species under consideration and have the same (1.6) relation between their length and width. As was mentioned, however, the truncated apertural end could not be observed well on account of the fragmentary condition of the specimens. This character appears to be of great importance because forms with an exserted apertural end described formerly as *Quinqueloculina seminula* L., for example, by Stadnichenko[32] or

[28]Galloway, J. J. and Wissler, S. G., Pleistocene Foraminifera from the Lomita Quarry, Palos Verdes Hills, California: Journ. Pal., I, p. 38.

[29]Thalmann, H. E., Nomeclator (Um- und Neubenennungen) zu den Tafeln 1 bis 115 in H. B. Brady's Werk uber die Foraminiferen der Challenger-Expedition, London, 1884: Ecl. Geol. Helvetiae, XXV, p. 296, 1932.

[30]Cushman, J. A. and Stewart, R. E. and K. C., Tertiary Foraminifera from Humbold County, California, A preliminary Survey of the Fauna: Trans. San Diego Soc. Nat. Hist., VI, p. 52, 1930.

[31]Contr. Cushman Lab., V, p. 60.

[32]Stadnichenko, M. M., The Foraminifera and Ostracoda of the marine Yegua of the Type Sections: Journ. Pal., I, p. 226, pl. 38, fig. 28, 1927.

Berry and Kelley[33] are separated now under a new specific name of *Quinqueloculina yeguaensis* Weinzierl & Applin.[34] There is also some doubt as to the real character of the apertural tooth. In his definition of the species quoted above, Cushman mentioned "a simple tooth," but in his fig. 18c, accompanying the description, the tooth becomes slightly bifid at the free end. The same discrepancy between description and figures is found in Cushman and Cahill's monograph of Miocene Foraminifera of the Coastal Plain,[35] but figures correspond to description in the monograph of the Foraminifera of the Atlantic Ocean.[36]

This species is widely distributed in waters of the Atlantic and the Pacific Oceans, chiefly in their northern sections, where often it is larger than forms of more southern areas. It is apparently absent in tropical waters.[37] Its vertical distribution is also very great as it was found in shallow waters and as deep as 3,000 fathoms.[38] Geologically, this species, appearing through the whole Tertiary, is, in general, particularly important in the Miocene and the Upper Tertiary. In Europe it was found abundantly in the Miocene of the Vienna Basin, in Rumania, etc., also in the Miocene of Egypt.[39] It is comparatively rare in the Choctawhatchee of Florida, but very abundant in the Miocene of Maryland, less so in the Miocene of Virginia. In the Panama Canal Zone it was found in the Culebra Formation, in the Gatun Formation, and also in the Pleistocene.

C. M. I. F. No. 6996-6999.

Quinqueloculina auberiana D'Orbigny

Plate XLII, figs. 35-36

1840. *Quinqueloculina auberinana* D'Orbigny, Foraminiferas: Historia fisica, politica y natural de la Isla de Cuba par D. Ramon de la Sagra, p. 167, lam. XII, figs. 1-3.

[33]Berry, W. and Kelley, L., The Foraminifera of the Ripley Formation on Coon Creek, Tennessee: U. S. Nat. Mus. Proc., 76, art. 19, p. 16, pl. 2, figs. 11-12, 1929.

[34]Weinzierl, L. L. and Applin, E. R., The Clairborne Formation on the Coastal Domes: Journ. Pal., III, p. 393, pl. 44, figs. 4a-b, 1929.

[35]U. S. G. S. Prof. Paper 175-A, p. 9.

[36]U. S. Nat. Mus. Bull. 104, part 6, p. 24.

[37]Ibidem, p. 25.

[38]Brady, op. cit., p. 160.

[39]Macfadyen, W. A., Miocene Foraminifera from the Clysmic Area of Egypt and Sinai: Geol. Survey of Egypt, p. 44, Cairo, 1930.

1884. *Miliolina auberiana* Brady, Report on the Foraminifera dredged by H. M. S. Challenger during the years 1873-1876: Challenger's Report, Zoology, IX, p. 162, pl. V, figs. 8a-c, 9.

1912. *Miliolina auberiana* Bagg, Pliocene and Pleistocene Foraminifera from Southern California: U. S. G. S. Bull. 513, p. 26, pl. IV, figs. 2a-b, (Synonymy).

1918. *Quinqueloculina auberiana* Cushman, The Smaller Fossil Foraminifera of the Panama Canal Zone: U. S. Nat. Mus. Bull. 103, p. 79, pl. 29, figs. 3a-c.

1918. *Quinqueloculina auberiana* Cushman, Some Pliocene and Miocene Foraminifera of the Coastal Plain of the United States: U. S. G. S. Bull. 676, p. 23, pl. V, figs. 3a-c; p. 71, pl. XXX, figs. 1a-c.

1930. *Quinqueloculina lamarckiana* Cushman, The Foraminifera of the Choctawhatchee Formation of Florida: Florida St. Geol. Survey, Bull. No. 4, p. 20, pl. 2, figs. 3a-c, 4a-b, 5a-c.

1930. *Quinqueloculina lamarckiana* Cushman and Valentine, Shallow Water Foraminifera from the Channel Island of Southern California: Contr. Dept. Geol. Stanford Univ., I, No. 1, p. 10, pl. 1, figs. 9a-c, 10a-c; pl. 2, figs. 2a-c.

1933. *Quinqueloculina lamarckiana* Cushman and Cahill, Miocene Foraminifera of the Coastal Plain of the Eastern United States: U. S. G. S. Prof. Paper 175-A, p. 9, pl. 2, figs. 4a-c, (Synonymy).

Test slightly longer than broad or about equally as long as broad. Chambers distinctly triangular in cross section with angled periphery easily distinguishable even in inner casts. Sutures somewhat depressed, distinct. Apertural end neither exsert, nor truncated. Wall smooth. One complete specimen is 0.5 mm. long, 0.4 mm. wide, and 0.3 mm. thick.

The Colombian form corresponds very closely to D'Orbigny's species in the shape of its chambers, acutely angled periphery, smooth surface, general shape, and the relation of the different dimensions. There is, however, some question as to which specific name might be used properly for this form. Cushman, who had used at first the name of *Quinqueloculina auberiana* D'Orb. substituted for it, in 1922, the name of *Quinqueloculina lamarckiana* D'Orb. He considered the two species to be identical and thought the latter one had the text priority,[40] as it had been described by D'Orbigny four pages ahead and figured on the preceding table to that of *Quinqueloculina auberiana* D'Orb. A comparison of original figures of the two species shows, however, a very distinct although small difference between them. *Quinqueloculina lamarckiana* D'Orb. has an exsert apertural end in the form of a short neck which *Quinqueloculina auberiana* D'Orb. lacks. The same character brought the separation of *Quinqueloculina yeguaensis* W. & A. from *Quinqueloculina seminula* L., and it may be considered

[40]Cushman, J. A., Foraminifera from the north coast of Jamaica: U. S. Nat. Mus. Proc. 59, No. 2360, p. 66.

sufficient to keep apart the two forms under consideration, both with angled periphery. Apparently Thalmann[41] is of the same opinion, since he mentions separately both *Quinqueloculina auberiana* D'Orb. and *Quinqueloculina lamarckiana* D'Orb.

Quinqueloculina auberiana D'Orb. is a common recent species of the littoral shallow water of tropical seas. Geologically, Brady considered as probable its existence in the Miocene of the Vienna Basin. Bagg accepted its geological range as being from the Miocene up to the present time. At the Panama Canal Zone it was described from the Pleistocene. From Pliocene and Miocene it was described from a number of localities of the Coastal Plain of the United States. In Colombia it was mentioned, although with some reservations, by Church,[42] from the lowest horizon M-N of the Tubera Group, that is, from the Lower Miocene.

C. M. I. F. No. 7072, 7078.

Quinqueloculina subquadrata sp. n.

Plate XLII, figs. 30-31

Test small, of almost square outlines, on the average about 0.25 mm. long and broad. Chambers rounded, not very distinct on account of shallow sutures. Periphery rounded. Apertural end somewhat truncated. Wall smooth.

This form is distinguished from other *Miliolidae* of the fauna by its small size and square outlines. *Quinqueloculina wadei* Berry[43] reminds one somewhat of the Colombian form, but has a more circular form than the latter.

C. M. I. F. No. 7073, 7079.

Family LAGENIDAE—NODOSARIINAE

LENTICULINA Lamarck

Lenticulina rotulata Lamarck

Plate XL, figs. 11-12

1806. *Lenticulites rotulata* Lamarck, Suite des mémoires sur les fossiles des environs de Paris: Ann. Mus. Hist. Nat. VIII, p. 188, pl. 62, fig. 11.

[41]Op. cit., p. 296.

[42]Anderson, F. M., Marine Miocene and related Deposits of North Colombia: Proc. Cal. Acad. Sc., IV Ser., XVIII, p. 179, 1929.

[43]Berry, W. and Kelley, L., The Foraminifera of the Ripley Formation on Coon Creek, Tennessee: U. S. Nat. Mus. Proc., 76, art. 19, p. 17, pl. 2, figs. 4-5.

1918. *Cristellaria rotulata* Cushman, The smaller fossil Foraminifera of the Panama Canal Zone: U. S. Nat. Mus. Bull. 103, p. 60, pl. 22, fig. 1, (Synonymy).

1923. *Cristellaria rotulata* Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 4, p. 108, pl. 28, figs. 1, 2.

1924. *Cristellaria rotulata* Hanna, G. D. and M. A., Foraminifera from the Eocene of Cowlitz River, Lewis County, Washington: Univ. Washington Publ. in Geology, I, No. 4, p. 61, pl. XIII, figs. 14, 19, 20.

1926. *Cristellaria rotulata* Plummer, Foraminifera of the Midway Formation in Texas: Univ. Texas Bull. 2644, p. 91, pl. VII, figs. 8a, b.

1927. *Lenticulina rotulata* Cushman, Notes on the Collection of Defrance: Contr. Cushman Lab. III, p. 142, pl. 28, fig. 7a-b.

1927. *Cristellaria rotulata* Stadnichenko, The Foraminifera and Ostracoda of the marine Yegua of the Type Sections: Journ. Pal. I, p. 228, pl. 38, figs. 12, 13, 29.

1931. *Lenticulina rotulata* Hanzawa, On some Miocene Rocks with Lepidocyclina from the Izu and Bôsô Peninsulas: Sc. Rept. Tahoku Imp. Univ., 2nd Ser. (Geology), p. 167, pl. II, figs. 15-16, (Synonymy).

Cristellaria rotulata Lamarck belongs to the most common Foraminifera having a very wide geographical, bathymetrical and geological distribution. It is found in the Arctic and in the tropics, in shallow water and as deep as 2,200 fathoms, and, beginning with the Upper Trias, occurs through all overlaying strata, being particularly abundant in the Tertiary where it has been discovered in almost every locality where a foraminiferal fauna[44] occurs. Accordingly, the synonymy of the species became so voluminous that, for example, Bagg finds it "too cumbersome to be given in full."[45] It is possible, however, that such a wide distribution is more apparent than real. As used to happen practically to all old species, the name of *Lenticulina rotulata* Lamarck was applied often rather indiscriminately to the forms which should be considered at least as good varieties of this species. Such varieties were mentioned, for example, from the Pliocene of California by Bagg.[46] Cushman, who found and reproduced Lamarck's type,[47] came to the conclusion that the typical form of this species is "restricted to the Upper Cretaceous of various parts of the world."[48] "Very many of the records for the species from Recent

[44]Brady, H. B., Op. cit., p. 548.

[45]Bagg, R. M., Miocene Foraminifera from the Monterey Shale of California: U. S. G. S. Bull. 268, p. 38, 1905.

[46]Bagg, R. M., Pliocene and Pleistocene Foraminifera from Southern California: U. S. G. S. Bull. 513, p. 67, 1912.

[47]Contr. Cushman Lab., III, l. c.

[48]Cushman, J. A., Cretaceous Foraminifera from Antigua, B. W. I.: Contr. Cushman Lab. VII, p. 37, 1931.

seas and from Tertiary deposits do not belong to the species, however" says he in another place in reference to this species.[49] As a result of all those remarks and criticisms there have been established lately many new species of Lenticulina which formerly would have been brought into association with *Lenticulina rotulata* Lamarck.

In the present paper this name is applied only to small *Cristellariae* tests of which are composed of seven or eight chambers. Their peripherial margin is acute, but without a distinct keel. Sutures, sometimes rather indistinct, are almost straight and bent only a very little. The central part is filled with the shell substance, not protruding, however, in the form of a plug, but following the general curvature of the surface. Diameter of the figured form over 0.4 mm., thickness about 0.3 mm.

The synonymy given above refers only to the Tertiary and Recent varieties corresponding to the form under consideration. From most of them the later is distinguishable generally by its much smaller size and by its central part, which is more confluent with the general surface of the test than usually shown on the quoted figures. In this respect some Cretaceous forms, as for example, those figured by Cushman from Coalinga[50] or by Plummer from Texas,[51] are much nearer to the Colombian form than the Tertiary ones. Among Tertiary forms, one very closely related is the variety from the Midway Formation of Texas.[52]

Only a few specimens of this species were found and it should be considered rare in the Colombian Miocene, as it is, indeed, in several other localities. For example, according to Bagg, "The species is exceedingly rare in the California Miocene"[53] as well as in the California Pliocene.[54] Stadnichenko,[55] who described this form from different localities of the Yegua Beds of Eastern Texas, found it every-

[49]Cushman, J. A. and Church, C. C., Some Upper Cretaceous Foraminifera from near Coalinga, Cal.: Proc. Cal. Acad. Sc., IV Ser, XVIII, p. 503, 1929.

[50]Ibidem, p. 503, pl. 37, figs. 1-2.

[51]Plummer, H. J., Some Cretaceous Foraminifera in Texas: Univ. Texas Bull. 3101, p. 142, pl. XI, fig. 20, 1931.

[52]Plummer, H. J., Univ. Texas Bull. 2644.

[53]Bagg, R. M., Miocene Foraminifera from the Monterey Shale of California: U. S. G. S. Bull. 268, p. 38, 1905.

[54]Bagg, R. M., Pliocene and Pleistocene Foraminifera from Southern California: U. S. G. S. Bull. 513, p. 67, 1912.

[55]l. c.

where rare or even extremely rare. On the contrary, according to Cushman, it "seems to be the commonest species in the Panamanian material."[56] It was found there in the lower part of the Culebra formation and in the Gatun Formation. Hanzawa also considers this form as common geologically, as widely distributed in the present time.[57]

C. M. I. F. No. 7000-7001.

Lenticulina colombiana sp. n.

Plate XL, figs. 14-15.

Test comparatively large, lenticular, regularly biconvex, involute. Periphery has a sharp edge, but no distinct keel. Wall smooth. Umbilicus absent. Sutures are limbate, slightly curved and extend to the center. They separate thirteen chambers in the last whorl. The length of the only complete specimen is 2.7 mm. (the diameter perpendicular to the length is 2.4 mm. long), the thickness 1.3 mm.

This species reminds one of the Tertiary forms of *Lenticulina rotulata* Lam., of about the same size and with as many chambers,[58] also of different related forms described, for example, by Cushman from the Atlantic Ocean.[59] The species under consideration is distinguishable from all of them by limbate sutures reaching to the center of the test and by the absence of an umbilicus.

C. M. I. F. No. 7003-7004.

Lenticulina lens sp. n.

Plate XL, figs. 16-17

Test rather small, but thick, regularly lenticular, strongly involute, composed of eight chambers. Periphery angled, but not keeled. Sutures slightly curved, thick, and a little depressed. Umbilicus large, but filled with the transparent shell substance which, however, does not protrude above the surface of the test. Surface smooth. Diameter about 1.4 mm., thickness 0.7 mm.

This species appears to be quite closely related to *Lenticulina rotulata* Lam. described above, but the latter is smaller than this species, its sutures are hardly seen through the shell, and the middle part of the test protrudes in the form of a boss.

C. M. I. F. No. 7005.

[56] l. c.

[57] l. c.

[58] Brady, H. B., Op. cit., p. 547, pl. LXIX, figs. 13a-b.

[59] U. S. Nat. Mus. Bull. 104, part 4.

Lenticulina multiseptae (?) Berry

Plate XL, fig. 13

1928. *Cristellaria multiseptae* Berry, The Foraminifera of the Restin Shale of Northwest Peru: Ecl. Geol. Helvetiae, XXI, p. 132, fig. 2. Basel.

One incomplete specimen of a *Lenticulina* is distinguished from the other species of the genus by numerous slightly protruding and curved sutures, the number of which is not less than fifteen. The umbilical part is somewhat raised. Diameter about 1.1 mm. Thickness 0.7 mm.

This form reminds one very strongly of *Lenticulina multiseptae* Berry, described from the Lobitos formation (Middle Eocene). However, the poor condition of the only specimen found and the schematic nature of the figure given by Berry do not permit one to consider the above identification other than tentative.

C. M. I. F. No. 7002.

Lenticulina orbicularis D'Orbigny

Plate XL, figs. 18-19

1826. *Robulina orbicularis* D'Orbigny, Tableau méthodique de la classe des céphalopodes: Ann. Sc. Nat. VII, p. 288, figs. 8-9.

1926. *Cristellaria orbicularis* Plummer, Foraminifera of the Midway Formation of Texas: Univ. Texas Bull. 2644, p. 92, pl. VII, figs. 1a-b, (Synonymy).

1928. *Cristellaria orbicularis* Nuttall, Tertiary Foraminifera from the Naparina Region of Trinidad (British West Indies): Quart. Journ. Geol. Soc., LXXXIV, p. 86, pl. V, fig. 4.

Test composed of long narrow chambers making sweeping curves terminating in the central umbo. Periphery extended and angulated, making a well defined keel. Sutures somewhat raised and slightly limbate. The figured specimen has a diameter of over 0.9 mm. and is over 0.5 mm. thick.

This species has been found in warm and cold zones of the Atlantic and Pacific Oceans, mostly in rather deep water, although it also occurs at a depth of only 38 fathoms. Fossil it was described in the Subappenine formations of Central Italy (Pliocene), in the Miocene of the Vienna Basin, in the Midway Formation of Texas where it is abundant in the upper part of the formation. It was described also from the so-called Upper Series of the Trinidad Tertiary.[60]

C. M. I. F. No. 7006-7007.

[60]Nuttall, l. c.

ROBULUS Montfort

Robulus lenticularis sp. n.

Plate XL, figs. 20-21

Test small, thick, closely coiled, completely involute, sharp on the edge, but without a keel. Surface white, porcellaneous, perfectly smooth, without any trace of septa on the surface. The chambers, numbering seven or eight to a whorl, could hardly be differentiated through the opaque wall. Aperture in the form of an elongate slit, typical for the genus. The figured specimen is about 0.6 mm. in diameter (a little over 0.6 mm. in one direction and little less than that in another). The thickness is over 0.3 mm.

The small size, regular lenticular shape, and smooth porcellaneous opaque wall characterize this species sufficiently as a new one.

C. M. I. F. No. 7008-7009.

DENTALINA D'Orbigny

Dentalina pauperata D'Orbigny

Plate XL, figs. 22-23

1846. *Dentalina pauperata* D'Orbigny, Foraminifères fossiles du Bassin Tertiaire de Vienne (Autriche), p. 46, pl. I, figs. 57, 58, Paris.[61]

1913. *Nodosaria pauperata* Cushman, A Monograph of the Foraminifera of the North Pacific Ocean: U. S. Nat. Mus. Bull. 71, part 3, p. 51, pl. 25, fig. 7, (Synonymy).

1922. *Dentalina pauperata* Protescu, Contribuţiuni la studiul faunei de foraminifere terţiare din România: Anuarul Institutului Geologic al Rumâniei, IX (1919-1920), p. 320, Tab. I, fig. 16.

1923. *Dentalina pauperata* Hanna, Some Eocene Foraminifera near Vacaville, California: Univ. California Publ. in Geol. Sc. XIV, No. 9, p. 322, pl. 58, figs. 3a-b, 5.

1929. *Dentalina pauperata* Cushman, A Late Tertiary Fauna of Venezuela and other related Regions: Contr. Cushman Lab., V, p. 85, pl. 12, figs. 23, 24.

1931. *Dentalina pauperata* Cushman & Laiming, Miocene Foraminifera from Los Sauces Creek, Ventura County, California: Journ. Pal. V, p. 99, pl. 10, figs. 11, 12.

An incomplete slightly arcuate specimen composed of five full chambers having about the same height and diameter but slightly tapering to one end. The earlier chambers are more cylindrical than the latter one, which is somewhat inflated. Sutures, therefore, are shallower in the early portion of the test than in the later one. Aperture round, central. Surface smooth with a few low, rather inconspicuous tubercles irregularly distributed over the surface. The length of the fragment is about 0.8 mm., diameter of the last chamber about 0.2 mm.

[61]Reproduced in Galloway's Plates of Foraminifera, V, p. 68.

This form is really cosmopolitan in present seas and is found in very different conditions from the near-shore habitat down to depths of 2,000-3,000 fathoms.[62] It has, also, a very wide geological range. Beginning with the Permian, it can be found in sediments of practically every later age. Originally, the species was described from the Miocene of Vienna, and is also known in the Miocene of Rumania. In the Miocene it was also found in California,[63] in Ecuador, Venezuela and Trinidad.[64] In California it was described by Hanna from the Eocene also.[65]

C. M. I. F. No. 7010.

Dentalina sp.

Plate XL, fig. 25

Two incomplete longitudinal sections belonging to the same species, the best of which, composed of six chambers, is figured. It tapers slightly to one end and is a little arcuate. Chambers of more spherical than cylindrical shape. The wall is rather thick. Apertures round, with short neck located a little excentrically. The length of the fragment 2.4 mm., the greatest diameter 0.6 mm.

On account of poor preservation, this form cannot be identified specifically. It is distinguished from two other *Dentalinae* in the fauna under consideration by the larger size and more spherical shape of the chambers. A longitudinal section of *Dentalina* sp. indet. from the Japanese Miocene[66] reminds one very much of the vertical section of the form under consideration.

C. M. I. F. No. 7012-7013.

Dentalina sp.

Plate XL, fig. 24

A cylindrical slightly arcuate fragment tapering very little to the lower bluntly rounded end. Four and one-half chambers preserved in the fragment are of cylindrical shape with the height a little less than the diameter and have very shallow hardly conspicuous sutures.

[62]Brady, H. B., Op. cit., p. 501.

[63]Bagg, R. M., Miocene Foraminifera from the Monterey Shale of California: U. S. G. S. Bull. 268, p. 322, pl. V, fig. 8, also J. A. Cushman and B. Laiming, l. c.

[64]Cushman, J. A., 1929, l. c.

[65]l. c.

[66]Hanzawa, Sh., On some Miocene Rocks with Lepidocyclina from the Izu and Bôsô Peninsulas: Sc. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geology), XII, No. 2A. p. 170, pl. XXVIII, fig. 17, 1931.

Surface smooth, slightly corroded. Length of the fragment about 0.8 mm., thickness 0.3 mm.

Nodosaria obliqua L. described by Cushman[67] from the Miocene of California, or at least the lower part of the test, is very similar to the form under consideration. So far as it is possible to judge from the description and figures, the Californian form is different from the Linnean species. *Dentalina communis* D'Orb. from different localities is also very similar to the form under consideration, as is shown by comparison with a form described from the Miocene of the Coastal Plain.[68]

C. M. I. F. No. 7011.

Family NONIONIDAE

ELPHIDIUM Montort.

Elphidium crispum Linnaeus.

Plate XL, figs. 26-27

1767. *Nautilus crispus* Linnaeus, Systema Naturae, 12 ed., p. 1162.

1914. *Polystomella crispa* Cushman, A Monograph of the Foraminifera of the North Pacific Ocean: U. S. Nat. Mus. Bull. 71, part 4, p. 32, pl. 18, figs. 1a, b. (Synonymy).

1918. *Polystomella crispa* Cushman, The smaller fossil Foraminifera of the Panama Canal Zone: U. S. Nat. Mus. Bull. 103, p. 76, pl. 27, figs. 2a, b.

1918. *Polystomella crispa* Cushman, Some Pliocene and Miocene Foraminifera of the Coastal Plain of the United States: U. S. G. S. Bull. 676, p. 69, pl. XXVII, figs. 1, 4, 5.

1920. *Polystomella crispa* Cushman, Lower Miocene Foraminifera of Florida: U. S. G. S. Prof. Paper. 128-B, p. 71, pl. XI, fig. 19.

1924. *Polystomella crispa* Van der Vlerk, Foraminiferen uit Het Tertiair van Java: Wetenschappelijke Mededeelingen, No. 1, p. 24, pl. V, fig. 28, 29, Weltevreden.

1927. *Themean crispus* Galloway & Wissler, Pleistocene Foraminifera from the Lomita Quarry, Palos Verdes Hills, California: Journ. Pal. I, p. 82, pl. 12, figs. 17a, b.

1927. *Elphidium crispum* Cushman & Grant, Late Tertiary and Quaternary Elphidiums of the West Coast of North America: Trans. San Diego Soc. Nat. Hist., V, No. 6, p. 73, pl. 7, figs. 2a-b, 3a-b.

1929. *Elphidium crispum* Cushman & Leavitt, On *Elphidium macellum* (Fichtel & Moll), *E. striato-punctatum* (Fichtel & Moll) and *E. crispum* (Linné): Contr. Cushman Lab. V, p. 20, pl. 4, figs. 3a, b, 4a, b.

[67]Cushman, J. A., Foraminifera of the typical Monterey of California: Contr. Cushman Lab., II, p. 56, pl. 7, fig. 5, 1926.

[68]Cushman, J. A. and Cahill, E. D., Miocene Foraminifera of the Coastal Plain of the Eastern United States: U. S. G. S. Prof. Paper 175-A, p. 14, pl. 5, fig. 2, 1933.

1929. *Polystomella* cfr. *crispa* Comerci, Di alcuni foraminiferi terziari dell' isola di Borneo: Boll. Soc. Geol. Ital., XLVII, p. 145, Tav. VIII, fig. 9.

1930. *Elphidium crispum* Cushman & Valentine, Shallow Water Foraminifera from the Channel Island of Southern California: Contr. Dept. Geol. Stanford Univ., I, No. 1, p. 21, pl. 5, figs. 12a-b.

Test bilaterally symmetrical, rather thick with the relation of the diameter to the thickness about 3:2, composed of twenty chambers in the last-formed coil. Periphery sharply angular. Umbilical region slightly convex, being filled up with clear shell material. Its diameter about $\frac{1}{6}$ of that of the test. Sutures are raised and somewhat limbate, but narrower than the bridged areas. Diameter of the figured specimen 0.4 mm., thickness 0.26 mm. Diameter of another specimen should be over 0.5 mm. Colombian specimens are distinguished from the typical form only by their relatively greater thickness.

Elphidium crispum L. is one of the most abundant, recent, shallow-water Foraminifera. It is also very common through the whole Tertiary, as well as in the Pleistocene. In the Panama Canal Zone it was found in the Gatun Formation. It is abundant in the Miocene of the Coastal Plain, especially in the Choctawhatchee and Chipole marls of Florida and in the Duplin marl in the Carolinas. It is also very common in the Pliocene and Pleistocene of California[69] and is known in the Lower Miocene of Java and Borneo and in many Tertiary localities of Europe, from which it was first described. From the west coast of North America it was mentioned by Cushman and Grant from a great number of Pliocene and recent localities. Particularly close to the Colombian form is the small variety from the Pleistocene of Magdalena Bay, Lower California, Mexico, and found as a recent form at Carmen Island, Gulf of California, Mexico.[70] In the fauna under consideration it is rare, being represented by only three specimens.

C. M. I. F. No. 7014-7015.

Family BULIMINIDAE (TURRILININAE)

BULIMINELLA Cushman

Buliminella pulchra sp. n.

Plate XL, fig. 28

Test regularly spiral, of three volutions, the last of which occupies about three-fourths of the whole height of the test. Sutures weli

[69]Bagg, R. M., Pliocene and Pleistocene Foraminifera from Southern California: U. S. G. S. Bull. 513, p. 90, pl. XXVII, figs. 13-20, XXVIII, figs. 1-6.

[70]Cushman, J. A. and Grant, IV, U. S., l. c.

marked between the last whorl and the previous one, rather indistinct in earlier stage. The final whorl has five or six chambers separated from each other by distinct sutures. Surface shining, smooth. Aperture elongate, slightly curved. Length about 0.3 mm., the greatest thickness about 0.2 mm.

This species is represented in the fauna by only one specimen, but this one is so well preserved that its description does not afford any difficulty. *Buliminella turbinata* Terq. from the Eocene of Paris[71] is very closely related to this one under consideration. Particularly it concerns the form represented on fig. 6 of Terquem's paper. The European form, however, has apparently more chambers in the last whorl than the American one. The other variety (Terquem's fig. 7) has less chambers than the first one, in this respect being more closely related to the Colombian form, but is more slender than the latter. Besides that, both European varieties have a rather round aperture. Also very closely related in its general shape is *Buliminella colonensis* Cushm. & Hedb. from the Colon Shale (Upper Cretaceous) of Venezuela.[72] The author's words: "This is really a unique species in its very broad form with the last formed coil occupying most of the area of the test," and also: "In some respects the species resembles Rotaliatina," may be applied to the species under consideration as well. The last coil of the Venezuelan form is, however, comparatively still larger than in *Buliminella pulchra* m. *Rotaliatina mexicana* Cushman,[73] the form most similar to these two *Buliminellas*, is stouter, has shallower sutures, and is, therefore, more or less ovate.

C. M. I. F. No. 7016.

BULIMINA D'Orbigny

Bulimina affinis D'Orbigny

Plate XL, fig. 29

1840. *Bulimina affinis* D'Orbigny, Foraminiferas: Historia fisica, politica y natural de la Isla de Cuba par D. Ramon de la Sagra, p. 109, lam. II, figs. 25 y 26.

1922. *Bulimina affinis* Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 3, p. 103, pl. 20, fig. 6, (Synonymy).

[71]Terquem, M., Les Foraminifères de l'Eocene des Environs des Paris: Mém. Soc. Géol. France, Ser. III, T. II, p. 113, pl. XII, figs. 6-7, Paris, 1882. Reproduction in Galloway's Plates of Foraminifera, VI, p. 117.

[72]Cushman, J. A. and Hedberg, H. D., Notes on some Foraminifera from Venezuela and Colombia: Contr. Cushman Lab., VI, p. 65, pl. 9, figs. 6-7, 1930.

[73]Cushman, J. A., New Foraminifera from the Upper Eocene of Mexico, Contr. Cushman Lab., I, p. 4, pl. I, figs. 1a, b, c. 1925.

1926. *Bulimina* sp. ? Cushman & Applin, Texas Jackson Foraminifera: Bull. Am. Asso. Pet. Geol., X, p. 169, pl. 7, figs. 10, 11.

1927. *Bulimina affinis* Franke, Die Foraminiferen und Ostracoden des Palaeocäns von Rugaard in Jütland und Jundkragen bei Kopenhagen: Danmarks geologiske Undersøgelse, II Raekke, No. 46, S, 11. Taf. I, Fig. 9, Kjøbenhavn.

1928. *Bulimina affinis* Nuttall, Tertiary Foraminifera from the Naparima Region of Trinidad (British West Indies): Quart. Journ. Geol. Soc., LXXXIV, p. 77, pl. III, fig. 6.

1931. *Bulimina brevis* Cushman, Cretaceous Foraminifera from Antigua, B. W. I.: Contr. Cushman Lab., VII, p. 40, pl. 5, figs. 9a-c.

1932. *Bulimina bicona* Berry, The Foraminifera of the Heath Formation of Northwestern Peru, South America: Ecl. Geol. Helvetiae, XXV, No. 1, p. 28, pl. III, figs. 13, 14.

Test conical, tapering from the broadly rounded apertural end toward the bluntly pointed apical one. Inflated chambers separated by well expressed sutures are arranged in three not very regular series. Wall smooth. Height of only specimen found over 0.4 mm., maximal thickness about 0.3 mm.

Brady described *Bulimina affinis* D'Orb.[74] along with *Bulimina ovata* D'Orb. and *Bulimina pupoides* D'Orb. as three varieties of the same species (*Bulimina affinis* D'Orb.) which cannot be separated from each other even as subspecies. However, *Bulimina affinis* D'Orb. is well distinguished from the two other species by its acuminate apical end, obovate apertural end, and by its apparently greater thickness. *Bulimina ovata* D'Orb. has the ends bluntly rounded and is broadly oval. *Bulimina pupoides* D'Orb. has an intermediate position between the two other species. In the recent paleontological literature all three names are used specifically, but often somewhat vaguely. It is not surprising, since the distinctive characters are variable and there are intermediate forms between the three species. A form described by Cushman from the Jackson Beds of Texas corresponds apparently very closely to *Bulimina affinis* D'Orb., but *Bulimina* sp. described by Cushman from the Eocene of the Moctezuma River[75] to which he refers in his description of the Texas form looks different. Judging from figures, *Bulimina brevis* D'Orb. described by Cushman from the Cretaceous of Antigua is nearer to *Bulimina affinis* D'Orb. than the species from Mexico. To a certain extent Cushman's description of this form supports this conclusion.

[74]Brady, H. B., Op. cit., p. 400, pl. L. figs. 13-15. To *Bulimina affinis* D'Orb., sens. str., refer figs. 14a-b.

[75]Cushman, J. A., An Eocene Fauna from the Moctezuma River, Mexico: Bull. Am. Asso. Pet. Geol. IX, p. 301, pl. 7, fig. 9, 1925.

He considers his *Bulimina brevis* D'Orb. as identical with *Bulimina ovula* Reuss, and the latter is identical, according to Brady,[76] with *Bulimina affinis* D'Orb. Figures of the original *Bulimina brevis* D'Orb. show a different form.

Bulimina affinis D'Orb., like the two other related species, is found abundantly in recent seas, Pliocene and in the whole Tertiary, but unlike them it goes down into the Cretaceous as well. It was originally described from the shore sands of the Island of Cuba and is abundantly found in the California Miocene[77] and in the so-called "Upper Series" of the Trinidad Tertiary.[78] It is a common form in the Lobitos Formation (Middle Eocene), of Northwestern Peru,[79] but is very rare there in the Heath Formation (Upper Oligocene). The latter statement refers, however, to the form described as *Bulimina bicona* Berry, the inclusion of which into the synonymy of D'Orbigny's species may not be considered as positively certain. Speaking of the geological distribution of these species, it is necessary to take into consideration the fact that it may be present in localities from which is mentioned only either *Bulimina ovata* D'Orb. or *Bulimina pupoides* D'Orb., or both. Particularly it refers to *Bulimina pupoides* D'Orb., many figures of which in different papers may be more correctly considered as representing *Bulimina affinis* D'Orb.

C. M. I. F. No. 7017.

Family BULIMINIDAE—UNIGERININAE

SIPHOGENERINA Schlumberger

Siphogenerina transversa Cushman

Plate XL, figs. 30-31

1918. *Siphogenerina raphanus* var. *transversus* Cushman, The Smaller Fossil Foraminifera of the Panama Canal Zone: U. S. Nat. Mus. Bull. 103, p. 64, pl. 22, fig. 8.

1926. *Siphogenerina raphanus* var. *transversus* Cushman, Foraminifera of the Genera Siphogenerina and Pavonina: U. S. Nat. Mus. Proc. 67, art. 25, p. 6, pl. 1, fig. 6 (reproduction of the original figure).

[76] l. c.

[77] Bagg, R. M., Jr., Miocene Foraminifera from the Monterey Shale of California: U. S. G. S. Bull. 268, p. 19, pl. II, fig. 1, 1905.

[78] Nuttall, l. c.

[79] Berry, E. W., The Foraminifera of the Restin Shale of Northwest Peru: Ecl. Geol. Helvetiae, XXI, 1928, p. 131; Berry, E. W., The Smaller Foraminifera of the Middle Lobitos Shale of N. W. Peru: Ibidem, p. 391.

1928. *Siphogenerina raphanus* var. *transversus* Nuttall, Tertiary Foraminifera from the Naparima Region of Trinidad (British West Indies): Quart. Journ. Geol. Soc., LXXXIV, p. 94, pl. VI, fig. 14.

1931. *Siphogenerina transversa* Cushman & Parker, Miocene Foraminifera from the Temblor of the East Side of the San Joaquin Valley, California: Contr. Cushman Lab., VII, p. 10, pl. 2, figs. 5, 6.

1931. *Siphogenerina transversa* Cushman & Laiming, Miocene Foraminifera from Los Sauces Creek, Ventura County, California: Journ. Pal., V, p. 112, pl. 12, fig. 13.

Small, rather stout, subcylindrical form slightly tapering toward the lower end. Upper end rounded, smooth with small circular central aperture. Neck absent, or, perhaps was not preserved. Great portion of the test uniserial. The earlier chambers cannot be well distinguished. Sutures prominent between the eight longitudinal ribs. Length of the only complete specimen is about 0.6 mm., thickness, at the upper end, about 0.3 mm. Dimensions of a fragment show that this form could be a little larger than the one described.

The Colombian form is, relatively, a little shorter than the typical form from the Panama Canal Zone and lacks the short neck of the latter. The difference in dimensions is, however, very small, and the neck could have been destroyed secondarily. The form from the Miocene of the San Joaquin Valley is more conical and that from the Ventura County larger and relatively longer than the typical form.

At the Panama Canal Zone, the species was described from the dark clay in the lower part of the Culebra Formation (Oligocene) where it is frequent. Cushman mentioned it also from Brasso, Trinidad (British West Indies)[80] which, according to Liddle[81] is of the Middle Miocene age. From the so-called Upper Series of the Trinidad Tertiary it was mentioned also by Nuttall.[82] In the Miocene of Venezuela it was indicated by Cushman.[83] In California it was found in the Miocene, where it occurs "in enormous numbers" in the Lower Temblor Formation, but is much less common in the Upper Temblor. The genus Siphogenerina, according to Cushman, "was exceptionally well developed in the Miocene of our own Pacific coast as well as in Panama, Trinidad, Florida, and Maryland."[84]

C. M. I. F. No. 7018-7019.

[80]U. S. Nat. Mus. Proc., 76, l. c.

[81]Liddle, R. A., The Geology of Venezuela and Trinidad, p. 467, Fort Worth, Texas, 1928.

[82]Nuttall, l. c.

[83]Journ. Pal. V, p. 112.

[84]Cushman, J. A., Siphogenerina plummeri a Species from the Upper Cretaceous of Texas: Contr. Cushman Lab. II, p. 15, 1926.

Family ROTALIIDAE—DISCORBISINAE

DISCORBIS Lamarck

Plate XL, fig. 33

Discorbis floridensis Cushman

Plate XL, fig. 32

1930. *Discorbis bertheloti* D'Orbigny var. *floridensis* Cushman & Jarvis, Miocene Foraminifera from Buff Bay, Jamaica: Journ. Pal. IV, p. 364, pl. 33, figs. 13a-c.
1931.[85] *Discorbis bertheloti* var. *floridensis* Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 8, p. 17, pl. 3, figs. 3-5.

Test broad, plano-convex, compressed. Periphery keeled. Chambers, five in the final whorl. These increase rapidly in size and the last one extends to not less than one-half of the periphery. The structure of the ventral side is unknown. Sutures distinct, depressed, slightly limbate. Wall smooth, very finely and evenly perforated. Diameter (in two directions) 0.7 mm. and 0.8 mm.; thickness a little over 0.2 mm.

The only specimen present, although incomplete and distorted, looks so closely related to Cushman's species that its identification as this species appears to be well justified. The form was described by Cushman as a new variety of *Discorbis bertheloti* D'Orb., but it is distinguished from the latter sufficiently to be considered independent.

C. M. I. F. No. 7020.

Discorbis atratiensis sp. n.

Plate XL, figs. 33-34

Test broad, plano-convex, with chambers slightly swollen on the dorsal side. Sutures depressed, and generally indistinct, which, when one considers the opaque wall, makes detailed description of the species rather difficult. Number of chambers in the final whorl, apparently, five. Wall smooth, very finely and evenly perforated on the dorsal side, but apparently without perforations on the ventral side. Diameters over 0.5 and 0.4 mm.; thickness 0.2 mm.

This species is well distinguished from *Discorbis floridensis* Cushman, to which it is very similar in its general form, by the smaller relative size of the last chamber, very little but distinctly swollen chambers on the dorsal side of the test, thin sutures, lack of keel and finer perforation of the wall.

C. M. I. F. No. 7021.

[85]This is the official year of publication. Description here given was already mentioned in Cushman and Jarvis' paper published in the Journal of Paleontology a year before.

GYROIDINA D'Orbigny

Gyroidina soldanii D'Orbigny

Plate XL, figs. 35-37

1926. *Gyroidina soldanii* D'Orbigny, Tableaux Méthodique de la classe de Céphalopodes: Ann. Sc. Nat., VII, p. 278, No. 5, Modèles de Céphalopodes, No. 36.

1931. *Gyroidina soldanii* Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 8, p. 38, pl. 8, figs. 3-8, (Synonymy).

1931. *Gyroidina soldanii* Cushman & Parker, Miocene Foraminifera from the Temblor of the East Side of the San Joaquin Valley, California: Contr. Cushman Lab., VII, p. 11, pl. 2, figs. 9a-b.

1931. *Gyroidina soldanii* Cushman & Laiming, Miocene Foraminifera from Los Sauces Creek, Ventura County, California: Journ. Pal., V, p. 114, pl. 13, figs. 2a-c.

Test trochoid, relatively high, plano-convex, with dorsal side almost flat or very slightly convex in the middle. Convexity appears greater than it is on account of circular shallow channel on this side, typical for the genus. Ventral side convex with a narrow umbilicus. Periphery almost flat. Peripherial edge only slightly rounded or subacute. Aperture an elongated slit at the inner margin of the chamber. Wall finely perforate, opaque. Sutures inconspicuous and chambers indistinct. Diameter of the only specimen about 0.5 mm.; the height 0.4 mm.

Gyroidina soldanii D'Orb. a very common form in recent seas is quoted from many Tertiary localities, going, perhaps down into the Cretaceous. Its separation from the other species of the same genus is, however, not always easy and even the volume of its variations is considered different in different cases. In describing this species from the Temblor formation Cushman and Parker pointed out that it "is subject to considerable variation in the same sample, or in any considerable suite of fossil or recent specimens from a single locality." Referring to the species from the Los Sauces Creek, Cushman and Laiming tell that it "does not vary greatly." When describing the forms from the Atlantic Ocean, Cushman did not include in the synonymy most of the fossil records "as many of them do not belong to this species." The form from Colombia is apparently closely related to species recently described from the Miocene of California, but somewhat different from the recent forms from the Atlantic Ocean which have more rounded periphery, more convex dorsal side than the fossil forms, and could hardly be distinguished, at least on the basis of figures, from the closely related Atlantic species of *Gyroidina orbicularis* D'Orb. Comparison of figures 1b and 2b on plate 8 of Cush-

man's Atlantic monograph, representing *Gyroidina orbicularis* D'Orb., with fig. 4c referring to *Gyroidina soldanii* D'Orb., shows that the former species could be distinguished from *Gyroidina soldanii* D'Orb. perhaps only by its smaller size and the left-handed spiral. The importance of the latter character is, however, still rather indefinite in Foraminifera in general and is particularly so in relation to the genus under consideration in which both right and left forms are described indiscriminately.

It is hardly possible to give a complete and correct list of geological localities for this species. By referring only to recent papers it is possible to mention that this species was found abundantly in the Upper Eocene of Ecuador,[86] in the Miocene of Venezuela and Trinidad, in the Miocene of the Coastal Plain of the United States,[87] and in the Miocene of California.[88] *Rotalia* cf. *soldanii* D'Orb. was mentioned by Berry from the Saman Shales of Peru.[89] It is found in seventeen localities of Egypt and the Peninsula of Sinai, and in some of them it is very frequent.[90]

C. M. I. F. No. 7022.

Gyroidina sp.

Plate XL, figs. 38-40

This species is distinguished from *Gyroidina soldanii* D'Orb., by its smaller size, rounded periphery and peripherical edge, and by its more convex dorsal side. Aperture an elongate slit at the inner margin of the chamber. Ventral side convex with a narrow umbilicus. Sutures indistinct, and number of chambers unknown. Wall smooth, opaque, finely perforate. Diameter about 0.4 mm.; height about 0.3 mm.

Apparently this form is very closely related to *Gyroidina soldanii* D'Orb. var. *rotundimargo* R. E. & K. C. Stewart,[91] from the Lower Pico (Lower Pliocene). Many peculiar features of the Californian form, chiefly referring to the character of sutures, could not be checked

[86]Galloway, J. J., and Morrey, M., A Lower Tertiary Foraminiferal Fauna from Manta, Ecuador: Bull. Am. Pal., XV, No. 55, p. 27, pl. 4, fig. 4, 1929.

[87]Cushman, J. A., A Late Tertiary Fauna of Venezuela and other Related Regions: Contr. Cushman Lab., V, p. 98, pl. 14, figs. 7a, b, 1929.

[88]Cushman and Parker, Cushman and Laiming, l. c.

[89]Berry, E. W., The Smaller Foraminifera of the Middle Lobitos Shale of Northwestern Peru: Ecl. Geol. Helvetiae, XXI, p. 392, Basel 1928.

[90]Macfadyen, W. A., Op. cit., p. 103.

[91]Stewart, R. E. and K. C., Post-Miocene Foraminifera from the Ventura Quadrangle, Ventura County, California: Journ. Pal. IV, p. 68, pl. 9, figs. 3a-c.

on the Colombian specimen. In addition, the figure of the Californian species shows a left-handed form while this one under consideration is normal right. Cushman, while describing the recent *Gyroidina soldanii* D'Orb. from the West Coast of America,[92] mentioned a variety of this species "with more rounded peripheral angle and less distinct chambers," which according to the Stewarts belongs to their variety. Probably, the same refers to the form described by Cushman and the Stewarts from the Pliocene of Humboldt County, California.[93] A young form of *Gyroidina soldanii* D'Orb., described by Cushman from South America,[94] is, probably, closely related to this Colombian form.

C. M. I. F. No. 7023.

Family ROTALIIDAE—ROTALIINAE

EPONIDES Montfort

Eponides antillarum D'Orbigny

Plate XLI, figs. 1-3

1840. *Rotalina antillarum* D'Orbigny, Foraminiferas: Historia fisica, politica y natural de la Isla de Cuba por D. Ramon de la Sagra, p. 89, lam. V, figs. 4-6.

1930. *Eponides antillarum* Cushman & Jarvis, Miocene Foraminifera from Buff Bay, Jamaica: Journ. Pal., IV, p. 364, pl. 33, figs. 14a-c, pl. 34, fig. 2.

1931. *Eponides antillarum* Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 8, p. 42, pl. 9, figs. 2a-c. (Synonymy).

Test trochoid, biconvex, with the dorsal side usually more convex than the ventral one. Periphery subacute. Chambers numerous, all visible from the dorsal side, only those of the last formed whorl, seven or eight in number, from the ventral side. Sutures very oblique on the dorsal side, rather indistinct or sometimes not visible at all. On the ventral side they are almost radiate and often limbate near the umbilicus, which is closed. Wall thick, smooth, porcellaneous, opaque. The species undergoes rather wide variations in its general shape, varying especially in its height. Forms having a thick wall and indistinct sutures could be brought into association with this species only by comparison with more transparent specimens and by tracing the

[92]Cushman, J. A., Recent Foraminifera from off the West Coast of America: Bull. Scripps Inst., Techn. Ser. I, No. 10, p. 162, 1927.

[93]Cushman, J. A. and Stewart, R. E. and K. C., Tertiary Foraminifera from Humboldt County, California: Trans. San Diego Soc. Nat. Hist., VI, No. 2, p. 72, pl. 6, figs. 1a-c, 1930.

[94]Cushman, J. A., A Late Tertiary Fauna of Venezuela and Other Related Regions: Contr. Cushman Lab. V, p. 98, pl. 14, figs. 6a-b, 1929.

alteration of this character. Such a form, for example, is figured by Cushman from Jamaica.[95]

DIMENSIONS IN MM.

Diameter	Height	
0.9	0.4	
0.8	0.5	
0.7	0.4	(figured specimen)
0.4	0.2	

This species is very common in the Colombian fauna. Its geographical and geological distribution appears to be rather limited chiefly because this species was usually identified as *Eponides schreibersii* D'Orb.,[96] and distinction of the two species is not established yet with desirable exactness. Probably the form described by Bagg,[97] under the name of *Pulvinula schreiberii* D'Orb. from the Eocene of Woodstock, Virginia, and the Miocene of the James River, Virginia, belongs to the species under consideration.

C. M. I. F. No. 7029-7030.

Eponides praecinctus Karrer

Plate XLI, figs. 4-6

1868. *Rotalia praecincta* Karrer, Die miocenenen Foraminiferen-fauna von Kostej im Banat: Sitz. Ber. d. K. Akad. Wiss., Bd. LXXXVIII, S. 189, Taf. V, Fig. 7, Wien.

1915. *Truncatulina praecincta* Cushman, A. Monograph of the Foraminifera of the North Pacific Ocean: U. S. Nat. Mus. Bull. 71, part 5, p. 39, figs. 42a-c, pl. 26, figs. 2a-c, (Synonymy).

1923. *Rotalia soldanii* Hanna, Some Eocene Foraminifera near Vacaville, California: Univ. California Publ., XIV, No. 9, p. 325, pl. 59, fig. 3a-c.

1930. *Rotalia soldanii* Krenzberg, Eine tertiäre Foraminiferen-fauna von Neuseeland: N. J. Abt. B., Beil. Bd. LXIV, S. 288, Taf. XXI, fig. 14a-c.

Test very variable in its general shape. Some specimens are almost equally biconvex with the ventral side only a little more convex than the dorsal one. In other specimens the dorsal side is flat or almost flat and the ventral one is conical, more or less high, with an acute

[95]Cushman, J. A., Foraminifera from the North Coast of Jamaica: U. S. Nat. Mus. Proc. 59, No. 2360, pl. 13, figs. 7, 8, 1921.

[96]D'Orbigny, A., Foraminifères fossiles du Bassin Tertiaire de Vienne (Autriche) p. 154, pl. VIII, figs. 4-6, Paris, 1846. (Reproduction in Galloway's Plates of Foraminifera, V, p. 84).

[97]Bagg, R. M., The Tertiary and Pleistocene Foraminifera of the Middle Atlantic Slope: Bull. Am. Pal., II, No. 10. p. 37, pl. 3, figs. 2a-c. 1898.

apex or quite blunt. The shape of the latter depends on the size of the umbilicus filled up with shell substance. Periphery acute, with a keel differently developed in different forms. The innermost whorls are covered on the dorsal side with a layer of shell substance and only about two whorls can be distinguished here. Chambers distinct, all of more or less uniform shape, not inflated, increasing in size only slightly and gradually. About ten chambers belong to the last-formed whorl. Sutures distinct, slightly limbate, neither depressed, nor protruding, confluent with the keel and spiral suture. They are strongly oblique on the dorsal side, rather radial and only slightly curved on the ventral side. Wall very finely perforate. Aperture in the form of a short slit at the base of the chambers.

DIMENSIONS IN MM.

Diameter	Thickness	Relation of heights of dorsal and ventral sides
0.7	0.4	
0.5	0.3	(figured specimen)
1.2	0.6	10:13

Some varieties of the Colombian form can hardly be distinguished from the Miocene *Rotalia praecincta* Karrer. From the Lower Miocene (so-called Ihungia layers) this species was described also from New Zealand, and from the Eocene of the Western Coast of North America. In recent seas this form has been found in many localities of the Pacific Ocean, apparently preferring warm and comparatively shallow waters.[98]

C. M. I. F. No. 7031-7032.

Eponides limbatus sp. n.

Plate XLI, figs. 7-9

Test trochoid, almost equally biconvex, with acute peripheral margin. Five or six narrow strongly curved chambers are distinguishable in the last-formed whorl. Sutures strongly limbate on both sides and raised on the dorsal one. Umbilicus filled with the shell material, the filling closely confluent with the round surface of the ventral side. Chambers and sutures rather indistinct here. Aperture poorly preserved, apparently located near the peripheral margin. Wall rather coarsely perforate, in some chambers pores distributed in rows along sutures. Diameters 0.35 and 0.4 mm.; height about 0.2 mm.

[98]Cushman, J. A., Foraminifera of the Philippine and Adjacent Seas: U. S. Nat. Mus. Bull. 100, vol. 4, p. 319, 1921.

The dorsal side of this species is very similar to that of *Rotalina concamerata* Will.,[99] whereas the English form is almost flat on the ventral side and somewhat umbilicate.

C. M. I. F. No. 7033.

Eponides sp.

Plate XLI, figs. 10-12

Test biconvex with almost equally high dorsal and ventral sides. Dorsal side regularly roundly convex. Ventral side more conical. Chambers numerous, 12-15 to the last formed whorl. They could not be distinguished on the dorsal side on account of the very thick wall and the same refers to the sutures which are here apparently only slightly bent. Sutures and chambers are better seen on the ventral side where the sutures run almost radially. The largest part of the ventral side is taken up by the massive filling of the umbilicus, which is closely connected with the wall of the test. Diameters of one specimen 0.43 and 0.4; its height 0.24 mm.

This form is closely related to *Eponides praecinctus* Karrer, from which it is distinguished chiefly by the massive plug in the umbilicus. The dorsal side is also a little different being more regularly round, but this roundness may be produced by the thickening of the wall of the test.

C. M. I. F. No. 7034-7035.

Family ROTALIIDAE—SIPHONININAE

SIPHONINA Reuss

Siphonina antioguiensis sp. n.

Plate XLI, figs. 13-15; pl. XLII, figs. 28-29

Test nearly circular, almost equally biconvex, with the ventral side only a little more convex than the dorsal one. Periphery subacute or even slightly keeled. Chambers are indistinct on the dorsal side. Four may be differentiated in the last-formed whorl on the ventral side separated here by depressed limbate sutures. Umbilicus filled with the shell material. Aperture elliptical with a low, but distinct, neck and rather thin lip. Wall smooth, perforated rather coarsely. Pores are more abundant on the ventral side than on the dorsal one and are distributed more or less concentrically in the central part of the former. Near the periphery the pores apparently reach the

[99]Williamson, W. C., On the Recent Foraminifera of Great Britain: The Ray Society, p. 52, pl. IV, figs. 101-105, London, 1858. Reproduced in Galloway's Plates of Foraminifera, I, p. 193.

surface obliquely and have, therefore, somewhat elliptical or comma-like shape, which makes the keel fimbriate, although it does not affect its peripherial margin.

DIMENSIONS IN MM.

Diameter	Thickness	Length of aperture
About 0.6	0.3	0.08
0.54	0.27	Inner cast

This species is very closely related to *Siphonina advena* Cushman, var. *eocenica* Cush. & Appl. as it is figured in Cushman's monograph[100] on this genus. There are, however, between these figures and those given primarily for this variety[101] some differences which do not permit one to consider the South American form identical with the North American one without direct comparison of both of them.

C. M. I. F. No. 7036, 7071.

Siphonina chocoiensis sp. n.

Plate XLI, figs. 16-18

Test biconvex, somewhat lobate, with the ventral side nearly twice as convex as the dorsal one. Periphery subacute. About five chambers on the dorsal side, separated by rather indistinct depressed septa. The periphery slightly fringed. Umbilicus filled. Aperture elliptical, without any neck but with a well expressed lip, located on the lower side of the marginal border. Wall smooth, rather coarsely perforated, although less so than in *Siphonina antioguiensis* m. Pores are round over the whole surface of the ventral side, rather scarce in the middle part of the dorsal side, but also very abundant here in the peripheral belt. On the marginal border they are a little stretched.

Diameter in two directions 0.43 and 0.38 mm., thickness 0.22 mm. This form is clearly distinguished from *Siphonina antioguiensis* m. by its general shape, lack of the apertural neck, and different perforation. *Siphonina chocoiensis* m. reminds one of some Eocene forms, since it is without the neck, and slightly lobate, as is *Siphonina prima* Plummer,[102] but it is distinguished from the latter by its general shape.

C. M. I. F. No. 7037.

[100] Cushman, J. A., Foraminifera of the genus Siphonina and Related Genera: Proc. U. S. Nat. Mus. 72, art. 20, p. 6, pl. 4, figs. 3a-c, 1927.

[101] Cushman, J. A., and Applin, E. R., Texas Jackson Foraminifera: Bull. Am. Asso. Pet. Geol., X, p. 182, pl. 10, figs. 18-19, 1926.

[102] Plummer, H. J., Foraminifera of the Midway Formation in Texas: Univ. Texas Bull. 2644, p. 148, pl. XII, figs. 4a-c. 1926.

Family AMPHISTEGINIDAE

AMPHISTEGINA D'Orbigny

Amphistegina lessoni D'Orbigny

Plate XL, figs. 43-44

1826. *Amphistegina lessoni* D'Orbigny, Tableau méthodique de la classe des Céphalopodes: Ann. d. Sc. Nat., VII, p. 304, pl. 17, figs. 1-4, Paris (Reproduced in Galloway's Plates of Foraminifera, I, p. 101).

1884. *Amphistegina lessoni* Brady, Report of the Foraminifera dredged by H. M. S. "Challenger," during the years 1873-1876: Challenger Report, Zoology, IX, p. 740, pl. CXI, figs. 1-4 (Figs. 5-7 excl.) Edinburgh.[103]

1898. *Amphistegina lessoni* Bagg, The Tertiary and Pleistocene Foraminifera of the Middle Atlantic Slope: Bull. Am. Pal., II, No. 10, p. 43, pl. I, figs. 6a-c.

1919. *Amphistegina lessoni* Cushman, Fossil Foraminifera from the West Indies: Carn. Inst. Washington Publ. 291, p. 50, pl. 7, fig. 7.

1924. *Amphistegina lessoni* Van der Vlerk, Foraminiferen uit Het Tertiair van Java: Wetenschappelijke Mededeelingen, No. 1, p. 23, pl. V, fig. 20, Weltevreden.

1928. *Nummulites carmenensis* Anderson, Notes on Lower Tertiary Deposits of Colombia and their Molluscan and Foraminiferal Fauna: Proc. Cal. Ac. Sc., IV Ser., XVII, p. 26, pl. 1, figs. 23, 24, San Francisco.

1929. *Amphistegina radiata* (ad partim) Yabe & Hanzawa, Tertiary foraminiferous Rocks of the Philippines: Sc. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geology), XI, No. 3, p. 179, pl. XVIII, fig. 6.

1930. *Amphistegina radiata* Yabe & Hanzawa, Tertiary foraminiferous Rocks of Taiwan (Formosa): Sc. Rep. Tôhoku Imp. Univ., XIV, No. 1, p. 39, pl. I, figs. 6, 8; II, fig. 5; III, fig. 6; V, figs. 6-7; VI, figs. 8, 12; VII, figs. 1, 2, 8, 9; VIII, figs. 1, 4, 5; IX, figs. 12, 13; XII, fig. 5; XIV, figs. 4, 5.

1930. *Amphistegina lessoni* Cushman, The Foraminifera of the Choctawhatchee Formation of Florida: Florida St. Geol. Survey, Bull. No. 4, p. 57, pl. 11, figs. 5a-c.

1931. *Amphistegina radiata* Hanzawa, Notes on Tertiary Foraminiferous Rocks from the Kwantô Mountainland, Japan: Sc. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geology), p. 156, pl. XXIV, fig. 7; pl. XXVI, figs. 6-8.

1932. *Amphistegina lessoni* Nuttall, Lower Oligocene Foraminifera from Mexico: Journ. Pal., VI, p. 27, pl. 6, fig. 12.

1933. *Amphistegina lessoni* Cushman & Cahill, Miocene Foraminifera of the Coastal Plain of the Eastern United States: U. S. G. S. Prof. Paper 175-A, p. 32, pl. 11, figs. 6a-c.

Test biconvex with many oblique chambers, the number of which, in the last formed whorl, may be more than 25. Sutures oblique and sharply angled near the periphery. The latter is bluntly rounded or

[103]According to Thalmann (Ecl. Geol. Helvetiae, XXV, p. 311) forms described by Brady should be named *Amphistegina radiata* Ficht. & Moll. Cushman, however, keeps Brady's identification for the forms described by the latter.

subacute in some specimens. The general shape is extremely variable, particularly with respect to the thickness, which may attain a half of the diameter or be less. The middle part of the test, the umbo, may be more or less prominent or may be confluent with the corresponding side of the test. Wall smooth.

DIMENSIONS IN MM.

	Diameter	Thickness	Number of chambers
Fig. 43	1.6	0.8	over 25
	1.1	0.6	over 20
Fig. 44	1.8	0.6	over 25
	2.4 (greatest d.)		about 27 (median section)

Amphistegina lessoni D'Orb. is the most common foraminifer in the fauna under consideration. Although variable in its general shape, it does not go beyond certain limits given in the above description in its variations. Neither the thick forms figured by Brady in figs. 5, 6, of the Challenger work, nor unsymmetrical varieties figured by him under No. 7, were found in the Colombian material. This shows that three groups of forms which Brady distinguished in the *Amphistegina lessoni* D'Orb. are more than individual variations of the same species. It is, therefore, hardly advisable to consider that all these varieties belong to the same species of *Amphistegina lessoni* D'Orb. as did Brady, and as has been done by most paleontologists who have dealt with this species. D'Orbigny himself was partly responsible for such a wide interpretation of his species because his model of *Amphistegina lessoni* D'Orb. does not correspond to his figures. Only the varieties described by Brady as "Compressed lenticular form" should be considered as belonging to *Amphistegina lessoni* D'Orb., *sensu stricto*. Figures 1-4 of Brady's monograph correspond well to those of D'Orbigny and at the same time show some amount of variation which si observed, for example, in the fauna under consideration. Brady's interpretation of the species was accepted by Cushman for the form of the North Pacific, although the variety figured by him has only a few chambers,[104] and also for the form from the Phillippines.[105] In his last paper on the Atlantic Foraminifera Cushman abandoned any attempt to complete references to this species, "As there are several

[104]Cushman, J. A., Monograph of the Foraminifera of the North Pacific Ocean: U. S. Nat. Mus. Bull. 71, part 4, p. 35, pl. 19, fig. 2, 1914.

[105]Cushman, J. A., Foraminifera of the Philippine and adjacent Seas: U. S. Nat. Mus. Bull. 100, vol. 4, p. 370, 1921.

species and varieties in the present oceans especially in the Indo-Pacific."[106] These words refer just as well to the fossil forms. The form figured in the last quoted paper of Cushman is different from the typical species, as it is interpreted in the present paper. *Amphistegina lessoni* D'Orb. was identified by Church from Colombia, where it was found within the lowest horizon, M-N, of the Tubera Group, Lower Miocene, according to Anderson.[107] Since no figures are given and the description does not contain any details about the characters of the species, it is not possible to be certain as to its systematic position. *Nummulites carmenensis* And., from the Middle Eocene of Colombia, may be an inner cast of *Amphistegina lessoni* D'Orb. At least, among many specimens of the latter species from Colombia, there are found inner casts which correspond exactly to the figures given by Anderson. The probability for such a guess is indicated to a certain extent, by the following remark of Anderson: "There is considerable difficulty in freeing the specimens from the matrix rock, and there is some indication that when fully mature the test does not present the radially ribbed appearance, shown in the photographs, but is coarsely nodose."[108] As the "radially ribbed surface" is the most important character of this species, its validity appears to the writer rather doubtful and in any case should be further checked.

The form described from the Panama Canal Zone[109] was not figured, but the description is complete enough to make one sure that it was *Amphistegina lessoni* D'Orb., *sens. str.* It was found here in the Culebra Formation and Emperador Limestone (Oligocene), also in the Gatun Formation (Miocene). On the Atlantic slope of North America this species was described from the Eocene of Woodstock, Virginia, and the Miocene of Darlington, South Carolina.[110] As is shown by the synonymy it is known in the Lower Oligocene of Mexico, in the Miocene of Jamaica, Florida, and several other localities of the Coastal Plain of the United States. The form described from the Lower Miocene of Java corresponds apparently very closely to the

[106]Cushman, J. A., The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 8, p. 79, pl. 16, figs. 1-3, 1931.

[107]Anderson, F. M., Marine Miocene and Related Deposits of North Colombia: Proc. Cal. Acad. Sc. IV Ser., XVIII, p. 179, 1929.

[108]l. c., p. 27.

[109]Cushman, J. A., The smaller fossil Foraminifera of the Panama Canal Zone: U. S. Nat. Mus. Bull. 103, p. 77, 1918.

[110]Bagg, R. M., Jr., l. c.

typical species. The Miocene form from Egypt is not figured but according to the description belongs to the typical variety.[111]

In the synonymy of this species is included also *Amphistegina radiata* Ficht. & M.,[112] described from different Miocene localities of Japan, because Japanese authors used this specific name very broadly, covering with it, also, the varieties corresponding to *Amphistegina lessoni* D'Orb.[113]

Amphistegina lessoni D'Orb. or, better to say, all the related species brought into this association being very common Tertiary forms are reported also from the Carboniferous and Triassic. The species is also abundantly found in recent seas, being typical particularly for shallow water sands of warm seas.

C. M. I. F. No. 7026-7028.

Amphistegina hauerina D'Orbigny

Plate XL, figs. 41-42

1846. *Amphistegina hauerina* D'Orbigny, Foraminifères fossiles du Bassin Tertiaire de Vienne (Autriche), p. 207, pl. XII, figs. 3-5, Paris. (Reproduced in Galloway's Plates of Foraminifera, V, p. 92).

The test of this species is distinguished from that of *Amphistegina lessoni* D'Orb. only by its general form. It has a rather strongly protruding, although not large umbonal boss, from which towards the periphery the surface of the test is a little concave. The periphery is subacute and even a little keeled.

DIMENSIONS IN MM.

Diameter	Thickness	Number of chambers
1.2	0.6	about 25, figured specimen
1.0	0.4	over 20
0.8	0.3	over 20

This form, described originally from the Miocene of Austria, was later included in the synonymy of *Amphistegina lessoni* D'Orb. and lost in the literature. It was, however, mentioned as a variety of the latter species from the Miocene of Egypt by Macfadyen.[114] As the

[111]Macfadyen, W. A., Op. cit. p. 106.

[112]*Nautilus radiatus* Fichtel, L. V. & Moll, J. P. C. v., Testacea microscopica aliaque minuta et generibus *Argonauta* et *Nautilus* ad naturam delineata et descripta, p. 58, Tab. 8, figs. a-d, Wien 1803 (Second Edition). After Galloway's Plates of Foraminifera, I, p. 23.

[113]Sc. Rep. Tôhoku Univ. 2nd Ser (Geology), XI, No. 3, p. 179.

[114]Op. cit., p. 107.

figures of D'Orbigny and also direct comparison with the Austrian specimen show, characters distinguishing the two species are well expressed and stable.

This species is well represented in the fauna under consideration.

C. M. I. F. No. 7024-7025.

Family GLOBIGERINIDAE—GLOBIGERININAE

GLOBIGERINA D'Orbigny

Globigerina bulloides D'Orbigny

Plate XLI, figs. 19-20

1826. *Globigerina bulloides* D'Orbigny, Tableau méthodique de la classe des Céphalopodes: Ann. Sc. Nat., VII, p. 277, No. 1, Modéles des Foraminifères No. 17, 76, Paris.

1914. *Globigerina bulloides* Cushman, A Monograph of the Foraminifera of the North Pacific Ocean: U. S. Nat. Mus. Bull. 71, part 4, p. 5, pl. 2, figs. 7-9, pl. 9, (Synonymy).

1918. *Globigerina bulloides* Cushman, Some Pliocene and Miocene Foraminifera of the Coastal Plain of the United States: U. S. G. S. Bull. 676, p. 56, pl. XII, figs. 4-6.

1920. *Globigerina bulloides* Cushman, Lower Miocene Foraminifera of Florida: U. S. G. S. Prof. Paper 128-B, p. 69, pl. XI, fig. 6.

1922. *Globigerina bulloides* Cushman, The Foraminifera of the Byram Calcareous Marl at Byram, Mississippi: U. S. G. S. Prof. Paper 129-E, p. 95, pl. XIX, figs. 1-3.

1924. *Globigerina bulloides* Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 5, p. 7, pl. 2, figs. 1-4.

1927. *Globigerina bulloides* Galloway & Wissler, Pleistocene Foraminifera from the Lomita Quarry, Palos Verdes Hills, California: Journ. Pal. I, p. 40, pl. 7, figs. 4a-c.

1928. *Globigerina bulloides* White, Some Index Foraminifera of the Tampico Embayment Area of Mexico: Journ. Pal. II, p. 192, pl. 27, fig. 12.

1928. *Globigerina bulloides* Cushman, Foraminifères du Stampien du Bassin de Paris: Bull. Soc. Sc. de Seine-& Oise, Sér. II, Tome IX, p. 56, pl. III, figs. 5a-c, 6a-c. Versailles.

1929. *Globigerina bulloides* Galloway & Morrey, A Lower Tertiary Foraminiferal Fauna from Manta, Ecuador: Bull. Am. Pal. XV, No. 55, p. 9, pl. 3, fig. 5.

1930. *Globigerina bulloides* Cole & Gillespie, Some Small Foraminifera from the Meson Formation of Mexico: Bull. Am. Pal. XV, No. 57b, p. 13, pl. 2, fig. 16.

1930. *Globigerina bulloides* Macfadyen, Miocene Foraminifera from the Clysmic Area of Egypt and Sinai: Geol. Surv. of Egypt, p. 94, pl. IV, figs. 2a, b, Cairo.

1930. *Globigerina bulloides* Cushman & Barksdale, Eocene Foraminifera from Martinez, California: Contr. Dept. Geology, Stanford University, I, p. 67, pl. 12, figs. 6a-b.

1931. *Globigerina bulloides* Hanzawa, Notes on some Eocene Foraminifera found in Taiwan (Formosa), with Remarks on the Age of the Hori Slate Formation and crystalline Schists: Tôhoku Imp. University Sc. Rep., 2 Ser. (Geology), XII, No. 2A, p. 177, pl. XXIX, figs. 10-12.

1931. *Globigerina bulloides* Cushman & Laiming, Miocene Foraminifera from Los Sauces Creek, Ventura County, California: Journ. Pal. V, p. 117, pl. 14, figs. 4a-c.

1932. *Globigerina bulloides* Nuttall, Lower Oligocene Foraminifera from Mexico: Journ. Pal. VI, p. 29, pl. 6, figs. 13-15.

Test subglobose, trochoid, composed of a few inflated subspherical chambers all of which are visible from the dorsal side, but only three or four of the last formed whorl may be seen from the ventral side. Sutures deep. Wall coarsely perforate. Average dimensions about 0.4 mm. in diameter.

Brady refers to this species as a cosmopolitan one which used to be found in all seas at almost every latitude and "in surface-gatherings wherever Foraminifera have been collected."[115] In later time, however, this statement could not be considered commonly accepted. In Cushman's opinion, for example, "*G. bulloides*, if present, is a very rare species in the western Atlantic"[116] and "it is not one characteristic species of the eastern Pacific."[117] Fossil *Globigerina bulloides* D'Orb. is also considered a very widely distributed form, but perhaps more critical identification of the species will bring the same results as revision of recent forms, that is, make its distribution much narrower than that now accepted. Bagg mentioned,[118] for example, that according to Terquem this species was already present in the Devonian. In Terquem's paper,[119] to which reference has been made, there was described a *Globigerina* without any specific name, thus it can only be interpreted as an indication of the appearance in the Devonian of the genus, not the presence of this particular species. It is, however, abundantly found in the Cretaceous and continues through the whole Tertiary towards Recent time.

As follows from the above given records, this species was described recently in the Western Hemisphere in California from the Pleisto-

[115]Brady, H. B., Op. cit., p. 595.

[116]Cushman, J. A., Recent Foraminifera from off the West Coast of America, Scripps Inst. Bull. Techn. Ser. I, No. 10, p. 171, 1927.

[117]U. S. Nat. Mus. Bull. 104, part 5, p. 7.

[118]Bagg, R. M., Jr., Pliocene and Pleistocene Foraminifera from Southern California: U. S. G. S. Bull. 513, p. 78, 1912.

[119]Terquem, O., Observations sur quelques fossiles des époques primaires: Bull. Soc. Géol. France, Sér. 3, VIII, p. 418, pl. XI, figs. 10a-e, Paris, 1880.

cene,[120] the Miocene,[121] in which sediments it was not before described,[122] and from the Eocene. In Mexico this species was found in the Upper Cretaceous[123] and in the Lower[124] and Middle[125] Oligocene. In Ecuador it was found in the Upper Eocene.[126] Along the Coastal Plain of the United States it was found in the Oligocene of Mississippi[127] and in the Miocene of Virginia and Florida.[128] In the Panama Canal Zone it was found in different localities of the Culebra Formation, as well as of the Gatun Formation.[129]

C. M. I. F. No. 7038-7039.

Globigerina tricamerata sp. n.

Plate XLI, fig. 21

1884. *Globigerina bulloides* var. *triloba* Brady, Report on the Foraminifera dredged by H. M. S. Challenger, during the years 1873-1876: Challenger Report, Zoology, IX, p. 595, pl. LXXXI, figs. 2-3, Edinburgh.

1931. *Globigerina bulloides* var. *tribloba* Hanzawa, Notes on some Eocene Foraminifera found in Taiwan (Formosa), with Remarks on the Age of the Hori Slate Formation and crystalline Schists: Sc. Rep. Tôhoku Imp. Univ., 2nd Ser. (Geology), XII, No. 2A, p. 182, pl. XXIX, fig. 12 (Synonymy).

1932. *Sphaeroidina* (?) *peruviana* Berry, The Foraminifera of the Heath Formation of Northwestern Peru, South America: Ecl. Geol. Helvetiae, XXV, No. 1, p. 29, pl. II, fig. 4.

Test subovoidal composed of three large final chambers, closely connected together, the last one of which almost equals in its size two other ones, or may be even larger than those. Sutures depressed, but not so deeply as usually in *Globigerinae*. Aperture not well known, apparently single and small on the last chamber, and opens into the umbilicus. Wall perforated rather coarsely. The length 0.32 mm.

[120]Journ. Pal. I, p. 40, pl. 7, figs. 4a-c.

[121]Journ. Pal. V, p. 117, pl. 14, figs. 4a-c.

[122]Bagg, R. M., Jr., Pliocene and Pleistocene Foraminifera from Southern California: U. S. G. S. Bull. 513, p. 77, pl. XXIII, figs. 2a-z, 3-8, 1912. Bagg, R. M., Jr., Miocene Foraminifera from the Monterey Shale of California with a few species from the Tejon Formation: U. S. G. S. Bull. 75, p. 41, pl. VII, fig. 7, 1905.

[123]Journ. Pal. II, p. 192, pl. 27, fig. 12.

[124]Journ. Pal. VI, p. 29, pl. 6, figs. 13-15.

[125]Cole and Gillespie, l. c.

[126]Bull. Am. Pal. XV, No. 55, p. 9, pl. 3, fig. 5.

[127]U. S. G. S. Prof. Pap. 129-E, p. 95, pl. XIX, figs. 1-3.

[128]U. S. G. S. Bull. 676, p. 56, pl. XII, figs. 4-6; U. S. G. S. Prof. Pap. 128-B, p. 69, pl. XI, fig. 6.

[129]Cushman, J. A., The Smaller fossil Foraminifera of the Panama Canal Zone: U. S. Nat. Mus. Bull. 103, p. 64, 1918.

A great confusion exists in the literature with reference to *Globigerina triloba* Reuss.[130] As may be seen on Reuss' figures, he described a form composed chiefly of three large chambers of the last formed whorl, but displayed also the small chambers of the preceding convolutions, and accessory apertures on the dorsal side of the test. Brady describing this form, as a variety of *Globigerina bulloides* D'Orb., gave figures of several rather different forms. His following description of forms "with final convolutions consisting of three relatively very large segments which sometimes form the entire visible shell," refers to figures 2 and 3 of Plate LXXXI, quoted above, and representing "bottom species." Varieties figured on Plate LXXIX are entirely different. There are, further, no supplementary apertures represented on Brady's figures, and he did not mention them in his description. Macfadyen was, probably, quite right in suggesting that supplemental apertures were probably not present in the specimens studied by Brady.[131] In the Egyptian specimens closely related to those of Austria, supplemental apertures were found often more numerous than stated by Reuss. Apparently Brady had in his hands forms similar to Reuss' species, but distinct enough to be considered specifically different. To the same conclusion apparently came Macfadyen. At least he did not include Challenger's forms in the synonymy of *Globigerina triloba* Reuss.

As a matter of fact, in most cases it is impossible to decide to which form the mention of *Globigerina triloba* Reuss refers, unless the description is accompanied by good figures. It may be the species under consideration, or *Globigerina bulloides* D'Orb., or *Globigerina trilocularis* m., next described. All three forms are closely related to each other, sometimes found together, and when not, may be considered vicarious from the stratigraphical point of view. The following data on the distribution of *Globigerina triloba* Reuss should be accepted, while keeping in mind these considerations. In the north Pacific Ocean, *Globigerina triloba* Reuss is found nearly everywhere with *Globigerina bulloides* D'Orb., but seems to be much less common.[132]

[130]Reuss, A. E., Neue Foraminiferen aus den Schichten des osterreichischen Tertiär-beckens: Denkschr. K. Akad. Wiss., Math. Nat. Wiss. Klasse, I, s. 374, Taf. XLVII, fig. 11a-e, Wien, 1850. Reproduced in Galloway's Plates of Foraminifera, V, p. 126.

[131]Macfadyen, W. A., Op. cit., p. 95.

[132]Cushman, J. A., A Monograph of the Foraminifera of the North Pacific Ocean: U. S. Nat. Mus. Bull. 71, part 4, p. 6, 1914.

It seems to be rare in the seas in the area of the Philippine Islands.[133] The species was found occasionally in the Panama Canal Zone in three localities of the Gatun Formation.[134] It was described from the Vicksburg Group of Mississippi.[135] In the Atlantic Ocean, according to Cushman, "Variety *triloba* Reuss is very nearly wanting.[136] Possibly this species was described by Hanzawa from the Japanese Eocene as a variety of *Globigerina bulloides* D'Orb. Into the above synonymy is included also *Sphaeroidina* (?) *peruviana* Berry from the Upper Oligocene of Peru, South America, which may belong to the variety described by Brady as, indeed, was suggested by Berry himself. In the fauna under consideration this species is almost as common as *Globigerina bulloides* D'Orb.

C. M. I. F. No. 7040-7041.

Globigerina trilocularis D'Orbigny

Plate XLI, figs. 22-23

1826. *Globigerina trilocularis* D'Orbigny, Tableau méthodique de la classe des Céphalopodes: Ann. Sc. Nat., VII, p. 277, No. 2.

1898. *Globigerina trilocularis* Fornasini, Le Sabbie Qialle Bolognesi e le Richerche di J. B. Beccari. Intonio ad Alcusir foraminiferi illustrati da O. G. Costa: Rendi Sess. R. Accad. Sc. Inst. Bologna, n. ser. II, p. 12, fig. 2,[137] fasc. 7, figs. 6, 7, 7a (Reproduced in Galloway's Plates of Foraminifera IV, p. 66).

1899. *Globigerina triloba* Egger, Foraminiferen und Ostracoden aus den Kreidemergeln der Oberbayerischen Alpen: Abh. Math. Phys. Kl. d. K. Bayer. Akad. Wiss. XXI, p. 171, Taf. XXI, fig. 8, München. Reproduced in Galloway's Plates of Foraminifera, VII, p. 154.

1920. *Globigerina bulloides* Cushman, Lower Miocene Foraminifera of Florida: U. S. G. S. Prof. Pap. 128-B, p. 69, pl. XI, fig. 6.

1926. *Globigerina triloculinoides* Plummer, Foraminifera of the Midway Formation in Texas: Univ. Texas Bull. 2644, p. 134, pl. VIII, figs. 10a-b.

1928. *Globigerina pseudotriloba* White, Some Index Foraminifera of the Tampico. Embayment Area of Mexico: Journ. Pal. II, p. 194, pl. 27, figs. 17a-b.

[133]Cushman, J. A., Foraminifera of the Philippine and Adjacent Seas: U. S. Nat. Mus. Bull. 100, Vol. 4, p. 286, 1921.

[134]Cushman, J. A., The Smaller Fossil Foraminifera of the Panama Canal Zone: U. S. Nat. Mus. Bull. 103, p. 65, 1918.

[135]Cushman, J. A., The Foraminifera of the Vicksburg Group: U. S. G. S. Prof. Paper 133, p. 35, 1923; Cushman, J. A., The Byram Calcareous Marl of Mississippi and its Foraminifera: U. S. G. S. Prof. Pap. 129-E, p. 95, 1922.

[136]Cushman, J. A., The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 5, p. 7, 1924.

[137]Reproduction of the unpublished figure by D'Orbigny of *Globigerian triolocularis* D'Orb. from the Middle Miocene of Bordeau, France.

1928. *Globigerina triangularis* White, Ibidem, p. 195, pl. 28, figs. 1a-b.

1928. *Globigerina velascoensis* White, (non Cushman) Ibidem, p. 196, pl. 28, figs 2a-b.

1929. *Globigerina triloba* Cushman & Wickenden, Recent Foraminifera from off Juan Fernandez Islands: U. S. Nat. Mus. Proc. 75, Art. 9, p. 13, pl. 6, figs. 1a-c.

1929. *Globigerina trilocularis* Galloway & Morrey, A Lower Tertiary Foraminiferal Fauna from Manta Ecuador: Bull. Am. Pal. XV, No. 55, p. 10, pl. 3, figs. 9a-b.

1931. *Globigerina triloculinoides* Galloway & Morrey, Late Cretaceous Foraminifera from Tabasco, Mexico: Journ. Pal. V, p. 348, pl. 39, figs. 11a-b.

Test more or less ovoidal, composed chiefly of three large chambers of the last-formed whorl, the last one of which is almost equal in its size to two preceding ones taken together. Sutures depressed but rather shallow and all three chambers together make a rather compact structure. Besides the three chambers, there can be seen several preceding chambers which are of much smaller size and separated from each other and from the three fundamental chambers by shallow sutures. They make a rather indistinct low convulution. Aperture apparently small, single, on the last chamber, opening into the umbilicus. Wall rather coarsely perforate. Length 0.32 mm.

This species is closely related to *Globigerina tricamerata* m. from which, as well as from *Globigerina triloba* Reuss,[138] it is distinguished only by the presence of former convolutions. The necessity of distinguishing this form from Reuss' species was shown by Plummer, in 1926, and a new specific name—*triloculinoides* was introduced by her. However, D'Orbigny had described, in 1826, without figures, *Globigerina trilocularis* D'Orb., which possesses characteristics required for the species under consideration, as it is now possible to see after the publication of D'Orbigny's figures by Fornasini. Simultaneously, the latter described this species also from the Pliocene. Three species described by White from the Mexican Upper Cretaceous correspond, in the writer's opinion, to D'Orbigny's species and are not sufficiently different from each other to be considered separately. The last of them does not correspond, apparently, to *Globigerina velascoensis* Cushman, as shows[139] a comparison with figures given by the latter author.

[138]Reuss, A. E., Neue Foraminiferen aus den Schichten des osterreichischen Tertiär-beckens: Denkschr. K. Akad. Wiss. Math. Nat. Wiss. Klasse, I, s. 374, Taf. XLVII, fig. 11a-3, Wien, 1850. (Reproduced in Galloway's Plates of Foraminifera, V, p. 126).

[139]Cushman, J. A., Some new Foraminifera from the Velasco Shale of Mexico: Contr. Cushman Lab., I, p. 19, pl. 3, figs. 5a-c.

As has been stated in the above synonymy, this species, described at first from the Miocene of France, was found in the Cretaceous, Eocene, Pliocene, and also recently in the Pacific Ocean. In the fauna under consideration it is rare.

C. M. I. F. No. 7042-7043.

Globigerina dutertrei D'Orbigny

Plate XLI, figs. 24-25

1840. *Globigerina dutertrei* D'Orbigny, Foraminiferas: Historia fisica, politica y natural de la isla de Cuba por D. Ramon de la Sagra, 5, p. 95, lam. IV, figs. 19-21, Paris.

1850. *Globigerina concinna* Reuss, Neue Foraminiferen aus den Schichten des oesterreichischen Tertiärbeckens: Denkschr. d. K. Akad. Wiss. Math. Naturw, Klasse, I, p. 373, Taf. XLVII, fig. 8a, b. Wien. (Reproduced in Galloway's Plates of Foraminifera, V, p. 126.)

1844. *Globigerina dutertrei* Brady, Report of the Foraminifera dredged by H. M. S. "Challenger" during the years of 1873-1876: Challenger Report, Zoology, IX, p. 601, pl. LXXXI, figs. 1a-c. Edinburgh.

1926. *Globigerina pseudo-bulloides* Plummer, Foraminifera of the Midway Formation in Texas: Univ. Texas Bull. No. 2644, p. 133, pl. VIII, figs. 9a-c.

1927. *Globigerina concinna* Galloway & Wissler, Pleistocene Foraminifera from the Limita Quarry, Palos Verdes Hills, California: Journ. Pal. I, p. 41, pl. 7, figs. 7a-c.

1929. *Globigerina conglomerata* Cushman & Wickenden, Recent Foraminifera from off Juan Fernandez Islands: U. S. Nat. Mus. Proc. 75, Art. 9, p. 12, figs. 6a-c.

1929. *Globigerina pseudo-bulloides* Galloway & Morrey, A Lower Tertiary Foraminiferal Fauna from Manta, Ecuador: Bull. Am. Pal. XV, No. 55, p. 10, pl. 3, 3, figs. 8a-c.

1931. *Globigerina pseudo-bulloides* Galloway & Morrey, Late Cretaceous Foraminifera from Tabasco, Mexico: Journ. Pal. V, p. 347, pl. 99, figs. 9a, b.

1932. *Globigerina concinna* Nuttall, Lower Oligocene Foraminifera from Mexico: Journ. Pal. VI, p. 29, pl. 6, figs. 9-11.

Test rotaliform, almost circular, convex on both sides, with thin and rounded periphery. The last whorl consists of five chambers gradually increasing in size, somewhat inflated, especially the last one. Sutures depressed. The earlier whorls may be seen on the dorsal side, but they are only indistinctly differentiated here. Aperture single and in the umbilical area on the inner side of the last-formed chamber. Wall rather coarsely perforated.

DIMENSIONS IN MM.

Diameter	Thickness
0.27–0.35	0.21

This species had been described by D'Orbigny from Cuba, but was never revised. In Cushman's opinion it is a "rather doubtful species"[140] concerning the characters and relations of which it is impossible to say anything definite "until D'Orbigny type specimen can be studied."[141] The most important feature of the species is the almost circular shape of the last-formed whorl and its construction of five inflated chambers gradually increasing in size, making a rather thick test, and also the position and shape of the single aperture. The character of the last-formed whorl well distinguishes this species from *Globigerina conglomerata* Schwager, in the synonymy of which *Globigerina dutertrei* D'Orb. is included by Thalmann.[142] As follows from the above synonymy, *Globigerina concinna* Reuss and *Globigerina pseudo-bulloides* Plummer, have been referred to D'Orbigny's species. Comparison of figures of all these species in the different articles quoted above shows distinctly that, in any case, they are very closely related forms. Since a "General chaos exists in the literature regarding the characteristics of Globigerine forms of this type,"[143] identification of this species may be only tentative.

According to the quoted literature, *Globigerina dutertrei* D'Orb. was found fossil in the Eocene of Texas and Ecuador, the Lower Oligocene of Mexico, the Miocene of Austria, and the Pleistocene of California. It is also a recent form of the Atlantic and possibly the Pacific Oceans, particularly if it would be correct to include in the synonymy of this species *Globigerina conglomerata* Schwager, from the Juan Fernandez Islands.

C. M. I. F. No. 7044-7045.

Globigerina conglomerata Schwager

Plate XLI, figs. 26-27

1866. *Globigerina conglomerata* Schwager, Fossile Foraminiferen von Kar Nikobar; Reise der oesterreichischen Fregatte Novara um die Erde, Geologischer Theil, II, s. 255, Taf. VII, fig. 113, Wien (Reproduced in Galloway's Plates of Foraminifera, IV, p. 35).

[140]Cushman, J. A., A Monograph of the Foraminifera of the North Pacific Ocean: U. S. Nat. Mus. Bull. 71, part 4, p. 8, 1914.

[141]Cushman, J. A., The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 5, p. 12, 1924.

[142]Thalmann, H. E., Nomeclator (Um-und Neubenennungen) zu den Tafeln 1 bis 115 in H. B. Brady's Werk uber die Foraminiferen der Challenger-Expedition, London 1884: Ecl. Geol. Helvetiae, XXV, p. 307.

[143]Plummer, Op. cit., p. 133.

1924. *Globigerina bulloides* (?) Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 5, p. 7, pl. 2, figs. 1-2.

1926. *Globigerina bulloides* D'Orb., var. *quadripartita* Koch, Mitteltertiäre Foraminiferen aus Bulangan, Ost-Borneo: Ecl. Geol. Helvetiae, XIX, S. 722, Fig. 20a-c, Basel.

1927. *Globigerina quadrilatera* Galloway & Wissler, Pleistocene Foraminifera from the Lomita Quarry, Palos Verdes Hills, California: Journ. Pal. I, p. 44, pl. 7, figs. 11a-c.

1928. *Globigerina quadrata* White, Some Index Foraminifera of the Tampico Embayment Area of Mexico: Journ. Pal. II, p. 195, pl. 27, figs. 18a-b.

1929. *Globigerina conglomerata* Galloway & Morrey, A Lower Tertiary Foraminiferal Fauna from Manta, Ecuador: Bull. Am. Pal. XV, No. 55, p. 9, pl. 3, figs. 7a-c.

1931. *Globigerina conglomerata* Cushman & Laiming, Miocene Foraminifera from Los Sauces Creek, Ventura County, California: Journ. Pal. V, p. 117, pl. 14, figs. 5a-c.

Test about quadrate, composed of nine or ten chambers, four of which, much larger than the rest, and regularly increasing in size, form the last whorl. Spire low-depressed. Sutures deeply depressed between chambers of the last-formed whorl, very little so between preceding chambers. Aperture could not be observed. Wall perforate rather coarsely. Length 0.41 mm.; thickness 0.26 mm.

Brady included this species in the synonymy of *Globigerina dubia* Egger,[144] although with some hesitation. Having had a chance to see Schwager's specimens, he had noticed some inaccuracy in the figures of the latter, but did not explain the defects. Figures of *Globigerina dubia* Egger in Brady's work and those of *Globigerina conglomerata* Schwager, making even a liberal allowance for the incorrectness of the latter, should be recognized to be incomparable. In spite of that, owing to the great authority of Brady, the latter species was almost lost in the literature by being absorbed, however, not by *Globigerina dubia* Egger, but oftener, apparently, by *Globigerina bulloides* D'Orb., as for example, in Cushman's work on the Foraminifera of the Atlantic Ocean. Typical for this species, is the almost quadrate shape of the last-formed whorl, consisting of four large chambers not so gradually increasing in size as do the five chambers of the last-formed whorl in *Globigerina dutertrei* D'Orb., which, according to Thalmann,[145] should be included in the synonymy of the species under consideration. All forms of different localities quoted in the

[144]Brady, H. B., Op. cit., p. 595, pl. LXXIX, figs. 17a-c. According to Thalmann (Ecl. Geol. Helvetiae, XXV, p. 307) it will be *Globigerina eggeri* Rhumbler.

[145]Ecl. Geol. Helvetiae, p. 307.

synonymy show well these features, although they vary somewhat in the thickness or the height of the test. All these varieties, however, could not be distinguished as separate species. The Colombian form is particularly like that from the Miocene of Los Sauces Creek.

As follows from the above synonymy, this species was found in the Upper Cretaceous, in the whole Tertiary system, with the exception of the Oligocene, and is known also in recent oceans. Brady also mentioned that Schwager's specimens were almost identical with the many recent ones.

In the Colombian fauna this species is very rare.

C. M. I. F. No. 7046, 7080.

GLOBIGERINOIDES Cushman

Globigerinoides conglobata Brady

Plate XLI, figs. 30-31

1884. *Globigerina conglobata* Brady, Report on the Foraminifera dredged by H. M. S. "Challenger," during the years 1873-1876: Challenger Report, Zoology, IX, p. 603, pl. LXXX, figs. 1-5, LXXXII, fig. 5, Edinburgh.

1924. *Globigerina conglobata* Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 5, p. 18, pl. 3, figs. 8-13, (Synonymy).

1928. *Globigerinoides conglobata* Cushman, Foraminifera, pl. 45, fig. 22.

Test subglobular, composed chiefly of the last three large chambers. Early chambers arranged in the form of a compact spiral. Aperture near the umbilicus. Secondary apertures could be observed only in a few specimens, mostly being obscured by the mineral deposit. Where they could be seen, they were small and few in number. Wall strongly perforate. The greatest diameter 0.4 mm.

Several specimens found in the fauna correspond very closely to the description and figures given by Brady. Lack or rarity of secondary apertures and their small dimensions, when present, can be attributed chiefly to conditions of preservation and practical impossibility to remove remnants of rock matrix. According to Brady, *Globigerina regularis* Reuss,[146] from the Miocene of Austria, is a "somewhat similar form" to that now under consideration. So far, however, as it is possible to judge from figures, the two forms are different.

[146]Reuss, A. E., Neue Foraminiferen aus den Schichten des osterreichischen Tertiärbeckens: Denkschr. d. K. Akad. Wiss., Math. Nat. Wiss. Klasse, I, s. 373, Taf. XLVII, fig. 7a, b, Wien 1850. (Reproduced in Galloway's Plates of Foraminifera, V, p. 126.)

Cushman described this species from two localities of the Gatun Formation, in the Panama Canal Zone.[147] On this occasion he mentioned that the species is almost unknown in fossil condition. It is, however, common in present seas. In the fauna under consideration it is rather abundant.

C. M. I. F. No. 7049-7050.

Family GLOBIGERINIDAE—PULLENIATININAE

PULLENIATINA Cushman

Pulleniatina obliquiloculata Parker & Jones

Plate XLI, figs. 28-29

1865. *Pullenia obliquiloculata* Parker & Jones, On Some Foraminifera from the North Atlantic and Arctic Oceans, including Davis Straits and Baffin Bay: Phil. Trans. CLV, p. 368, pl. XIX, figs. 4a, b. London. (Reproduced in Galloway's Plates of Foraminifera, II, p. 128).

1924. *Pullenia obliquiloculata* Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 5, p. 43, pl. 8, figs. 10a, b. (Synonymy).

1927. *Pulleniatina obliqueloculata* Cushman, An Outline of a Re-Classification of the Foraminifera: Contr. Cushman Lab., III, p. 90, pl. 19, figs. 5a-b.

Test subglobular, rather irregularly coiled and composed of five swollen chambers, concealing former volutions. Three chambers are seen on one side, four on the other. Sutures depressed, but only moderately. Wall smooth, shiny, finely perforate. Aperture elongate, narrow, curved between the ventral face of the last-formed chamber and the next one. The largest diameter 0.3 mm.

This species is represented in the fauna only by two specimens, of which one is complete. It is distinguished a little from the typical representatives by its somewhat irregular coiling and rather small size.

The species has a very wide distribution in recent seas, but, by most writers, is considered unknown in fossil condition. So far as the writer recollects, it was described as a fossil only by Cushman from the Miocene marl found at a gorge of Yunnuri River, Matanzas, Cuba,[148] where it is rare.

C. M. I. F. No. 7047-7048.

[147]Cushman, J. A., The Smaller Fossil Foraminifera of the Panama Canal Zone: U. S. Nat. Mus. Bull. 103, p. 66, 1918.

[148]Cushman, J. A., Fossil Foraminifera from the West Indies: Carnegie Inst. Wash. Publ. No. 291, p. 40, Washington, 1919.

Family ANOMALINIDAE—ANOMALININAE

PLANULINA D'Orbigny

Planulina bradii sp. n.

Plate XLI, figs. 32-34

1884. *Truncatulina wuellerstorfi* Brady, Report on the Foraminifera dredged by H. M. S. "Challenger," during the years 1873-1876: Challenger Report, Zoology, vol. IX, p. 662, pl. XCIII, figs. 8a-c, Edinburgh.

1931. *Planulina wuellerstorfi* Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 8, p. 110, pl. 19, figs. 5a-c.

Test plano-convex, with dorsal side nearly flat and ventral one almost half ball-shaped, slightly compressed in the middle umbilicate area. Periphery subacute. Chambers to the number of eleven in the last-formed whorl are well distinct on the ventral side, bent, three of them slightly swollen, the last one the most so. Sutures distinctly seen on the ventral side, not so well on the dorsal side, are limbate, curved with an angle, neither raised nor depressed. Aperture at the periphery, extending on the dorsal side along the margin of the chamber in the form of a slit. Surface smooth, glossy, finely perforate. Diameter 0.46 mm.; thickness about 0.22 mm.

As follows from the above synonymy, this species was described by Brady as a variety of *Anomalina wuellerstorfi* Schwager, described by the latter from the Pliocene of Kar Nikobar.[149] Brady figured two varieties, one of which, fig. 9 of his work, he called "the most typical specimen." Another variety, less typical, of his fig. 8, is now under consideration. Recently, Cushman revised Schwager's species and gave new figures of it based on Schwager's material from the type locality[150] corresponding to original figures by Schwager, but different from the figure 8 given by Brady. In Cushman's words: "This is a thick form and not typical." He emphasized also the fact that both varieties described by Brady had been found in different and very distant localities. This one of fig. 8, west of Ireland, and that of fig. 9, on the West Coast of New Zealand. Unfortunately both varieties were often used indiscriminately as representing Schwager's species and, certainly, some misrepresentation has been created in this way as to the systematic scope of this species and its geographical and geological distribution.

[149]Reise der oesterreichischen Fregatte Navara um die Erde, Geologischer Theil, Bd. II, S. 258, Taf. VII, Fig. 105, Wien, 1866. (Reproduced in Galloway's Plates of Foraminifera, IV, p. 35.)

[150]Cushman, J. A., Planulina ariminensis D'Orbigny and P. wuellerstorfi (Schwager): Contr. Cushman Lab. V, p. 104, pl. 15, figs. 1a-c. 2a-c, 1929.

The generic association of Schwager's species also arouses some doubts, which certainly apply to the species under consideration. As Cushman mentioned: "It tends toward Cibicides in many specimens."[151] Many paleontologists bring it into this association.[152] The aperture corresponds exactly to that of *Cibicides* Montfort. General form, especially in the species under consideration, corresponds more to that of *Cibicides* Montfort than to that of *Planulina* D'Orb. The latter, according to Cushman's classification, should have "Test nearly symmetrical."[153] The test, however, is less trochoid than is typical for *Cibicides* Montfort.

C. M. I. F. No. 7051.

Planulina elegans sp. n.

Plate XLI, figs. 35-37

Test plano-convex. Dorsal side flat. Ventral one more or less regularly convex, slightly concave in the middle, corresponding to a shallow umbilicus, and with a shallow spiral depression near the subangulate and keeled periphery. Chambers, nine in the last-formed whorl, well distinct on the ventral side. The last chamber, triangular in shape, strongly swollen. Sutures distinct on the ventral side, limbate, bent with an angle, a little depressed. Aperture not preserved, but, apparently, was at the periphery and extended on the dorsal side. Surface smooth, glossy, finely perforate. Diameter about 0.5 mm.; thickness about 0.16 mm.

This species is rather closely related to *Planulina bradii* m., but can be easily distinguished from it by many features. It is thinner than the former species and its ventral side has a different shape. The periphery is keeled. The chambers are in lesser number, and their shape is a little different. The sutures are a little depressed. *Cibicides dohertyi* Gall. & Morr., from the Upper Eocene of Ecuador, also reminds one of the species under description,[154] but is distinguished from the latter by the biconvex test, slightly lobulate periphery, and larger dimensions.

[151]U. S. Nat. Mus. Bull. 104, part 8, p. 111.

[152]Galloway, J. J. and Morrey, M., A Lower Tertiary Foraminiferal Fauna from Manta, Ecuador: Bull. Am. Pal. XV, No. 55, p. 31.

[153]Cushman, J. A., Foraminifera, p. 315, 1928.

[154]Galloway, J. J. and Morrey, M., A Lower Tertiary Foraminiferal Fauna from Manta, Ecuador: Bull. Am. Pal. XV, No. 55, p. 30, pl. 4, fig. 7, 1929.

The generic association of *Planulina elegans* m., as in the case of the previous species, is not quite positively fixed. It is quite possible that some paleontologists would be more inclined to bring both species into association with the genus *Cibicides* Montfort rather than with the genus *Planulina* D'Orb.

C. M. I. F. No. 7052.

Family ANOMALINIDAE—CIBICIDINAE

CIBICIDES Montfort

Cibicides risseri White

Plate XLII, figs. 1-3

1928. *Cibicides risseri* White, Some Index Foraminifera of the Tampico Embayment Area of Mexico: Journ. Pal. II, p. 298, pl. 40, figs. 10a-c.

Test unequally biconvex, with the ventral side almost twice as high as the dorsal one. Dorsal side roundly convex. Ventral side slightly flattened in the middle. Periphery subacute. No sutures can be distinguished on the dorsal side, and only the last whorl is separated here. Eight or nine swollen chambers are seen on the ventral side separated by depressed almost radial sutures. Umbilicus small, shallow. Aperture apparently normal. Diameter about 0.4 mm.; thickness 0.2 mm.

The only difference which it is possible to notice between the Colombian and Mexican forms is in the structure of the dorsal side of the former. The Mexican form shows on the dorsal side distinctly swollen chambers and depressed sutures while the dorsal side of the Colombian form is almost uniformly smooth. *Cibicides risseri* Wh. was described from the middle portion of the Velasco (Upper Cretaceous).

C. M. I. F. No. 7053.

Cibicides pseudoungerianus Cushman

Plate XLII, figs. 4-6

1922. *Truncatulina pseudoungeriana* Cushman, The Foraminifera of the Byram Calcareous Marl at Byram, Mississippi: U. S. G. S. Prof. Paper 129-E, p. 97, pl. XX, fig. 9.

1930. *Truncatulina pseudoungeriana* Cole & Gillespie, Some small Foraminifera from the Meson Formation of Mexico: Bull. Am. Pal. XV, No. 57-b, p. 15, pl. 3, figs. 10-11.

1931. *Cibicides pseudoungeriana* Cushman, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull. 104, part 8, p. 123, pl. 22, figs. 3-7.

1933. *Cibicides pseudoungerianus* Ellisor, Jackson Group of Formations in Texas with Notes on Frio and Vicksburg: Bull. Am. A. Petsso. Geol., XVII, pl. 5, figs. 3, 4a-b.

Test trochoid, unequally biconvex, with rounded dorsal side and more conical ventral one. In some specimens the ventral side is about twice as high as the dorsal one. In other cases they are almost subequal. Periphery subacute. Chambers numerous, not less than 10-12 in the last whorl, but they are distinguishable with difficulty on account of the opaque wall. Sutures can be distinguished on the dorsal side in the last whorl only, as all previous whorls are covered with a layer of test material. Most of the sutures are neither raised nor depressed, except the two last ones on the ventral side, which are more or less strongly depressed. The two last chambers are swollen, which gives this species its peculiar shape. Umbilicus filled with the test material. Wall perforated. Aperture peripheral and extends on the dorsal side. Diameter up to 0.5 mm. with thickness about 0.2 mm. or a little more.

The only difference between the Colombian form and those figured by Cushman is that the sutures of the former are a little less distinct. Besides that, the Colombian form is left-handed.

This species was described from the Lower Oligocene of Vicksburg, Mississippi, was found in the Culebra Formation of the Panama Canal Zone,[155] in the Middle Eocene of Mexico, and in the Vicksburg Formation of Texas. It is also a very common recent form.

C. M. I. F. No. 7054-7055.

Cibicides mckannai (?) Galloway & Wissler

Plate XLII, figs. 7-11

1927. *Cibicides mckannai* Galloway & Wissler, Pleistocene Foraminifera from the Lomita Quarry, Palos Verdes Hills, California: Journ. Pal. I, p. 65, pl. 10, figs. 5a-c, 6a-c.

Test trochoid, left- and right-handed, equally, or unequally biconvex. In the latter case the dorsal side is more rounded, but less convex than the ventral one. Chambers numerous, about twelve to the last whorl, uniform in shape, rather narrow. Periphery acute and keeled. Sutures strongly curved on the dorsal side, less so on the ventral one, limbate in both cases. The dorsal side covered with a porous layer of the shell material, which covers the whole surface with the exception of the last whorl, thus obscuring earlier whorls completely. Umbilicus filled with the same material, making a smaller or larger boss, closely fused together with the test. Wall coarsely perforate.

[155]U. S. G. S. Prof. Paper 129-E, p. 97.

DIMENSIONS IN MM.

	Diameter	Thickness	Relation of the heights of dorsal and ventral sides.
Fig. 11 Left form incomplete	0.54	about 0.3	3:2
Fig. 10 Left form	0.54	over 0.2	1:1
Figs. 7-9 Right form	0.46 and 0.4	over 0.2	4:5

The Colombian form is closely related to the Californian species, and so far as their dorsal sides are concerned they could be considered identical. The ventral side of the latter lacks, however, the raised sutures, which are well developed in the former. This character is considered by Galloway and Wissler to be very important and to distinguish their species from *Cibicides floridanus* Cushman.[156] However, in the most recent description of his species Cushman[157] figured a form with depressed sutures on the ventral side. Both species are undoubtedly very closely related and are distinguishable from each other not as much by the character of their sutures as by the more numerous and narrow chambers of *Cibicides mckannai* Gall. & Wissl., despite the fact that the latter form, in general, is smaller than *Cibicides floridanus* Cushman.

C. M. I. F. No. 7056-7060.

Cibicides colombianus sp. n.

Plate XLII, figs. 12-15

Test unequally biconvex with the dorsal side about twice as low as the ventral one. Periphery angulate, but without a keel. Chambers uniform, numerous, about 10-12 to the last whorl. The early volutions are covered on the dorsal side with a layer of the shell material. Sutures only slightly bent, often inconspicuous, mostly limbate, but neither raised nor depressed. Umbilicus filled with the shell material. Aperture typical for the genus. Wall shining, glossy, perforate. Right- and left-handed forms are present in the collection about in equal number. Diameter of the left figured specimen 0.4 mm.; thickness about 0.2 mm. The right figured specimen is 0.35 mm. in diameter.

In its general shape, this form is closely related to *Cibicides mckannai* (?) Gall. & Wissl., especially as to the smaller specimens of the latter.

[156]Cushman, J. A., Some Pliocene and Miocene Foraminifera of the Coastal Plain of the United States: U. S. G. S. Bull. 676, p. 62, pl. XIX, figs. 2a, b, c, 1918.

[157]Cushman, J. A. and Laiming, B., Miocene Foraminifera from Los Sauces Creek, Ventura County, California: Journ. Pal. V, p. 119, pl. 14, figs. 8a-c, 1931.

Its sutures are, however, not protruding as in the latter, also no keel is present, although the periphery is angular.

This species is very common in the fauna under consideration.

C. M. I. F. No. 7061-7062, 7069-7070.

Cibicides atratiensis sp. n.

Plate XLII, figs. 16-18

Test unequally biconvex with the ventral side more than twice as high as the dorsal one. Periphery acute, keeled. Central part of the dorsal side slightly raised on account of a secondary layer of the shell material covering the inner whorls. Chambers numerous up to 13 in the last-formed whorl in a specimen which is less than 0.4 mm. in diameter. Sutures distinct, slightly limbate, but neither raised, nor depressed. Last chamber slightly swollen. Umbilicus filled with the shell material, making a rather strong boss. Aperture apparently typical for the genus. Surface glossy and rather coarsely perforate. Diameter up to 0.4 mm., height less than 0.2 mm.

In its general shape, this species reminds one of *Cibicides colombianus* m., but it has a keel, which the latter lacks. The number of chambers in the last whorl of *Cibicides atratiensis* m. is also a little greater than in the latter. The same characters distinguish this species from *Cibicides pseudoungerianus* Cushman, described above, in common with which this species has swollen last chambers. The difference from the latter species is, however, even greater than in the former case, since Cushman's species, while being a little larger than this one under consideration, has less chambers in the last-formed whorl.

C. M. I. F. No. 7063-7064.

Cibicides depressus sp. n.

Plate XLII, figs. 19-21

The dorsal side of the test slightly concave. Ventral side rather strongly convex, especially in the left variety, less so in the right one, slightly depressed or even umbilicate at the center. Peripheral margin rather acute. Chambers numerous, but not well distinguished. Ten to twelve could be assigned to the last whorl. Chambers of the inner whorl, nine in number, are seen on the dorsal side of the left variety in the form of faint punctations. Only a few of them can be distinguished on the dorsal side of the right variety. Sutures are thin, slightly depressed and rather indistinct. Wall smooth, even glossy in the right variety, finely perforate. Aperture on the lower side near the edge goes over to the dorsal side in the form of a slit.

DIMENSIONS IN MM.

	Two Diameters	Thickness
R.	0.32 and 0.41	0.14
L.	0.41 and 0.51	0.22

This species reminds one of *Cibicides lobatulus* Walk. & Jac.,[158] particularly the varieties figured by Brady,[159] but is well distinguishable from the latter by its more numerous chambers, although its general dimensions are much smaller. It is entirely different from the very lobate forms figured by Walker with which, also, the forms figured by Brady could hardly be connected. It is possible, however, that the lobate structure was much exaggerated on the original figures. Recent *Cibicides* sp. from the Juan Fernandez Islands, particularly the form represented on fig. 4 of Cushman and Wickenden's paper, is apparently closely related to the species under consideration.[160]

C. M. I. F. No. 7065-7066.

Cibicides concavus sp. n.

Plate XLII, figs. 22-24

Test concavo-convex, with the dorsal side slightly concave and ventral side roundly convex. Umbilicus narrow, with a small but distinct plug. Peripheral margin subacute. Chambers, eight in number, increase in size with the growth of the test, the last two of them being particularly large and rather irregular. Sutures a little limbate, and on the ventral side slightly depressed. Aperture not preserved, although some markings near the edge on the dorsal side may be considered the remnant of the upper slit. Wall glossy, finely perforate. Diameter in two directions 0.54 mm. and 0.46 mm.; thickness 0.15 mm.

Cibicides concavus m. is distinguished from *Cibicides lobatulus* Walk. & Jac.,[161] with which this species is closely related, by lack of lobation and by the presence of the well expressed plug in the umbili-

[158]Walker, G., Testacea minuta rariora etc., p. 20, pl. III, fig. 71, London, 1784. (Reproduced in Galloway's Plates of Foraminifera, I, p. 19).

[159]Brady, H. B., Op. cit., p. 660, pls. XCII, fig. 10; XCIII, figs. 1a-c, 4, 5; CXV, figs. 4, 5.

[160]Cushman, J. A. and Wickenden, R. T. D., Recent Foraminifera from off Juan Fernandez Islands: U. S. Nat. Mus. Proc., 75, art. 9, p. 15, pl. 6, figs. 4, 8, 1929.

[161]Walker, G., Op. cit.

cus. The presence of the plug and the lesser number of chambers distinguishes it, also, from *Cibicides depressus* m.

C. M. I. F. No. 7067.

Cibicides nephridium sp. n.

Plate XLII, figs. 25-27

Test plano-convex, oval. Dorsal side almost flat or a little convex, being about five times lower than the ventral one. Peripheral margin round. Of seven chambers present, the two last ones are large. Sutures are somewhat limbate, made of the transparent shell material, and rather well distinguished. The last one is somewhat depressed, others are on the level of the test. Umbilicus closed with a comparatively large plug hardly separated from the surface of the ventral side. Aperture on the ventral side close to the peripheral margin and extending over onto the dorsal side. Wall finely perforated. Diameters in two directions equal 0.46 mm. and 0.36 mm.; thickness 0.16 mm.

This species is related also with *Cibicides lobatulus* Walk. & Jac.,[162] but is distinguished by the lack of lobation, by the flat or somewhat convex dorsal side, and by the presence of a plug in the umbilicus. It is possible, also, that it was a free form not attached by its dorsal side. Its general shape distinguishes it from *Cibicides concavus* m. with which it has in common the number of chambers and a plug in the umbilicus.

C. M. I. F. No. 7068, 7081.

[162]Walker, G., Op. cit.

DESCRIPTION OF THE FLORA

ANGIOSPERMAE—DICOTYLEDONEAE

SPERMITES Saporta

Spermites fragilis sp. n.

Plate XLII, figs. 37-39

A small hollow fragment of a crescent shape which suggests an ovoid body slightly and somewhat unsymmetrically compressed laterally. Surface smooth, aside from a few erosion marks, and a small elliptical ring on the round end—a trace of some kind of an attachment. The shell is rather thick on the round end, becomes thinner, although still comparatively thick, toward the horns of the crescent, but was probably thin on both sides. The other broken-off end had probably a similar structure. The interior of the shell is smooth with the exception of a slightly marked scar at the thicker end. Estimated length was probably about 1.5 mm.; width 1.1 mm.; thickness 0.7 mm.

The described fragment is all that is present for the identification of this interesting fossil, the interpretation of which, even a quite hypothetical one, caused much trouble and study. It would be easier and perhaps more reasonable not to bother about this fragment at all and leave it without any description, but it would be, however, a real pity not to mention it.

Among Foraminifera there are several genera with a single chambered test to which, apparently, it would be possible to refer the specimen under consideration. All those genera have, however, the test more or less ball-shaped or flask-like and, when regular, are radially symmetrical. The test is usually arenaceous and uniformly thick. When parts of the wall are thicker than usual, they are distributed irregularly.

The fragment under consideration is bilaterally symmetrical. Its test is homogeneous. Variations of thickness are regular and distributed according to the general shape of the fossil and its symmetry. The inside scar and the outer attachment-spot do not find anything analogous in the Foraminifera. Relationship to the Foraminifera cannot, therefore, be accepted for this fragment.

Besides Foraminifera, there are no animal forms with which this interesting form could be compared. Its bilaterally symmetrical shape, inner scar, and outer attachment-spot, remind one of some seeds of the Dicotyledoneae. It hardly might be, however, a shell of a seed because, in that case, the shell would have a rather uniform thickness and not have such a strong and regular variation of thickness as observed in the fragment under consideration. It may be, however, a fragment of an inner cast of a seed. In this case the inner cavity may be interpreted as a mould of the embryo and the whole fragment as a cast of the endosperm.[163]

It is hardly possible to identify this fragment more exactly than has been done above, particularly to establish any relationship with some genus of Dicotyledoneae. The generic name *Spermites* may be, however, well applied to the form under consideration because this provisional genus was established by Saporta[164] for "Toutes les graines de nature indéterminée" described by him in the fossil flora of Aix-en-Province under three specific names. Every one of these species might be identified, eventually, in a proper way and find its association with some other genus. The emergency genus *Spermites* would thus become, in this way, a *nomen nudum*. Excepting by Saporta, himself, this generic name was never used by any other paleophytologist and is practically lost in paleobotanical literature. At least, the writer was unable to find a reference to it in the literature available to him. In the catalogue of the National Museum there are only the names of three species described by Saporta at the time of publication of the generic name.[165] It was used by Saporta in a case of emergency and in this sense is used in the present paper. In spite of the very fragmentary condition of the only specimen, its specific independence can be considered well established.

(C. M. Paleophytological collection).

[163]The writer feels greatly obliged to Dr. O. E. Jennings of Carnegie Museum for the friendly help given in disclosing the nature of this interesting fossil.

[164]Saporta, M. G. de, Dernières adjonctions à la flore fossile d'Aix-en-Province (2 ième partie): Ann. Sc. Nat., 2 Sér., Botanique, II, p. 142, Paris, 1889.

[165]For this information the writer is obliged to Dr. David White of the U. S. Geological Survey.

ALGAE

CORALLINACEAE

LITHOTHAMNIUM Philippi

Lithothamnium colombianum sp. n.

Plate XLII, figs. 40-43; pls. XLIII and XLIV

Among different pebbles separated out of the rock examined there were numerous limestone pebbles mostly of a more or less regular, elongated, rounded shape, sometimes subcylindrical, often irregular, although still rounded. They attain the length of 5 mm., but most of them are smaller. Treatment with HCl and examination of thin slides revealed the structure typical for the *Corallinaceae*. The shape of their thallus is unknown. However, the shape of some such pebbles, although rolled out in water, would depend clearly on the original form of the thallus, and would be determined, also, by the connection between the exterior form and their inner structure. All pebbles examined were undoubtedly short rounded branches protruding, probably, from the exposed face of the alga, which is not preserved in such a complete manner. Owing to the conditions of preservation, no slide showed the structure of the whole thallus. The microstructure of the hypothallium and perithallium, however, could be observed separately in different slides.

Both hypothallium and perithallium are composed of numerous concentric layers of cells, but the hypothallium could be distinguished by its "coaxial" structure, composed of rows of cells radiating out from a central point and by the absence of conceptacles, also by more regular concentric structure. The cells of the hypothallium are a little longer in the direction of their radiation than in their width, the dimensions being correspondingly 0.015-0.018 mm. by 0.011 mm. The cells of the perithallium are a little smaller than those of the hypothallium, subquadrate, or sometimes even a little broader than high, measuring about 0.011 mm. in diameter. Their height does not exceed 0.012 mm. and width 0.009 mm. Conceptacles are few, distributed irregularly, being embedded within the perithallium. Their identification as such is not absolutely certain. Two of them measured 0.30 mm. by 0.42 mm., and 0.13 mm. by 0.25 mm.

By its micro-structure the species under consideration reminds one very closely of *Lithothamnium isthmi* Howe,[166] from the Emperador

[166]Howe, Marshall A., On some Fossil and Recent Lithothamnieae of the Panama Canal Zone: U. S. Nat. Mus. Bull. 103, p. 8, pl. 7, fig. 3; plates 9, 10 and 11. 1918.

limestone (Oligocene) of the Panama Canal Zone. The only difference between these two species is a little smaller size of the cells in the one from Colombia. The size of the cells in *Lithothamnium isthmi* Howe, however, is very variable and some of them correspond in size to the dimensions given above. The rather narrow limits of the size of cells of *Lithothamnium colombianum* m. perhaps might be explained by the somewhat scarce material. With more abundant material it might be possible to meet with a greater variability in the size of cells in the Colombian form than is observed now. It might then, eventually, be necessary to bring both species together under the same specific name *Lithothamnium isthmi* Howe.

(C. M. Paleobotanical collection).